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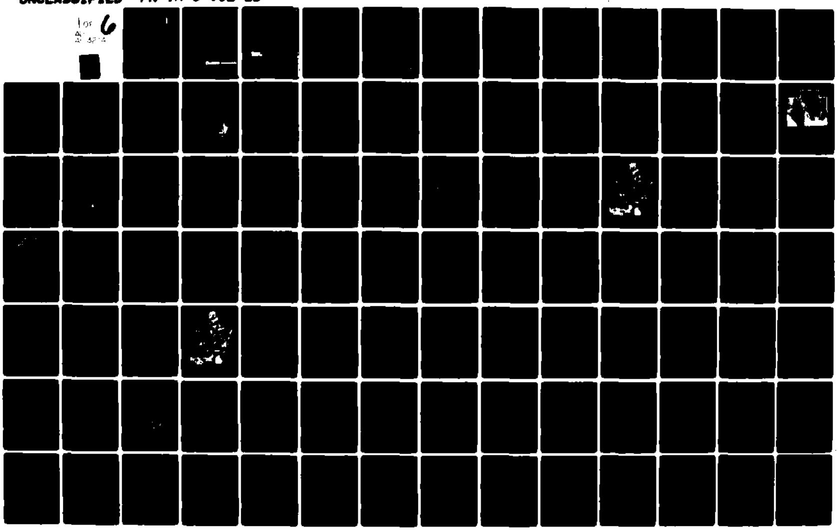

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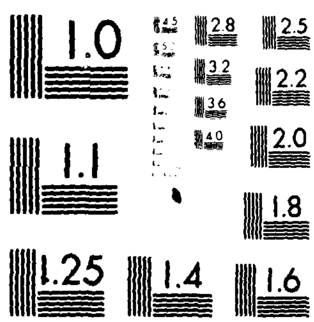

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CONSULTING

MX SITING INVESTIGATION
VOLUME IIB
GEOTECHNICAL REPORT
YUMA PROVING GROUNDS/LUKE-
WILLIAMS BOMBING AND GUNNERY
RANGE (YPG/LWBGR)

Conducted for:

Department of the Air Force - SAMSO
Contract No.: F04701-74-D-0013

By:

Fugro National, Inc.
Project No.: N-74-066-EG

30 June 1975

FUGRO NATIONAL, INC.

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The overall geotechnical evaluation investigation dealt with Department of Defense areas. This volume IIB is one of the areas. The area of study is located in southwestern Arizona. Included is a review of existing geotechnical information regarding the area.

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1.0 INTRODUCTION

1.1 FORWARD

This report was prepared for the Department of the Air Force, Space and Missile Systems Organization (SAMSO), in compliance with conditions of the statement of work as part of Contract No. F04701-74-D-0013 and deals with siting of the MX Land Mobile Advanced ICBM system. This contract was authorized under Program Element 63305F as described in the 26 February, 1973 Missile X Program Plan.

This report was prepared for SAMSO by Elaine J. Bell, Charles N. Partlow and James R. Miller, with final graphics preparation by Edd V. Joy and James A. Nenneman. Technical review and partial preparation of this report was performed by Kenneth L. Wilson and Robert J. Lynn, Senior Geologists and Kenneth D. Hill, Senior Engineer. TRW Systems personnel monitored the study for SAMSO.

The overall Geotechnical Evaluation Investigation dealt with three separate Department of Defense (DoD) areas (Figure 1); the combined Yuma Proving Grounds/Luke-Williams Bombing and Gunnery Range (YPG/LWBGR) is the subject of this report (Volume IIB). Results of the studies for the combined White Sands Missile Range/Fort Bliss Military Reservation (Volume IIA) and for the Nellis Air Force Base Bombing and Gunnery Range (Volume IIC) are presented separately.

Results of the YPG/LWBGR study are presented in a written format and as large (37" x 42") map and overlay graphics.

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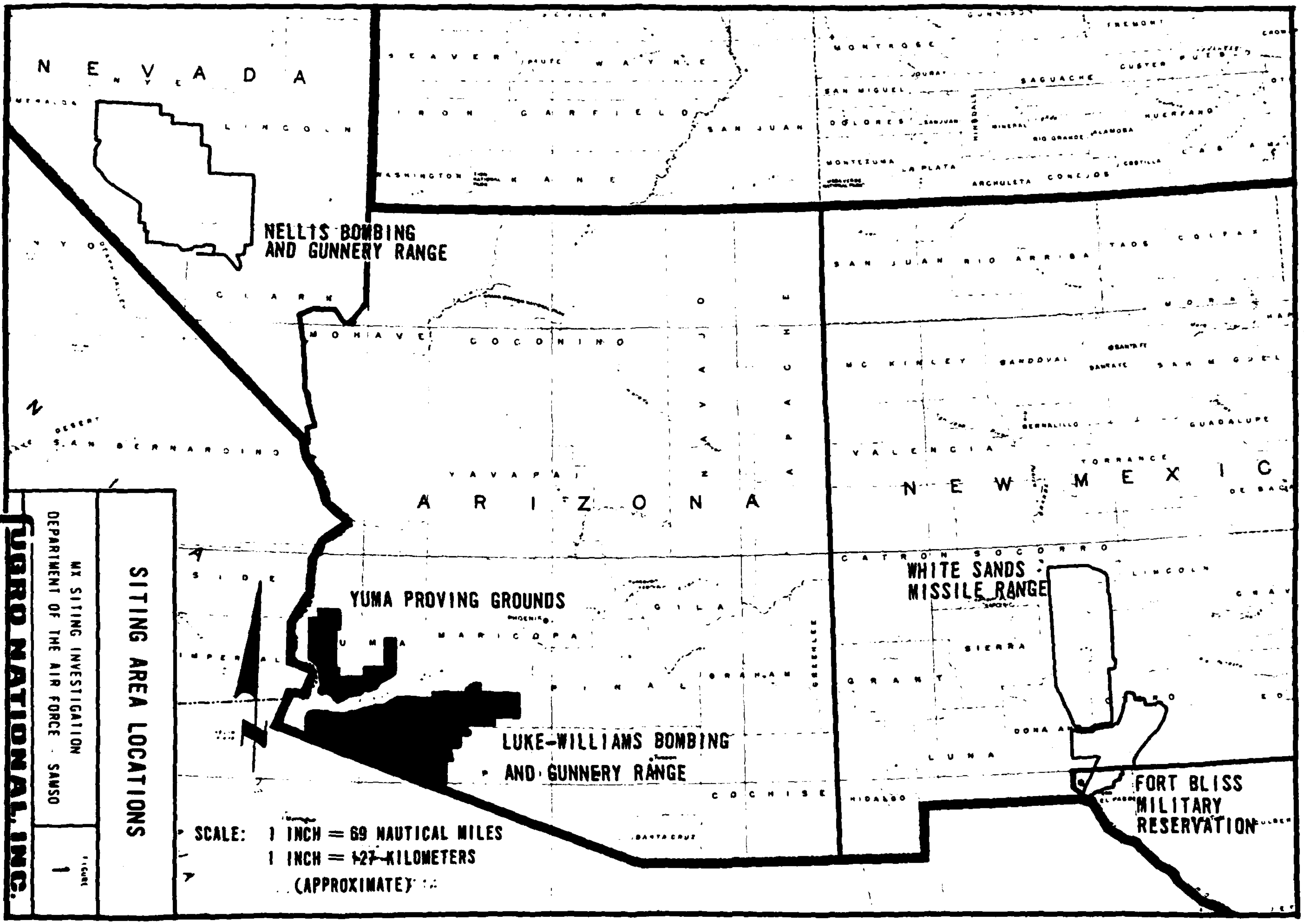

SITING AREA LOCATIONS

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE 1

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Written materials for this Geotechnical Evaluation Investigation are presented in four volumes which specifically consist of:

Volume I - Siting Evaluation Report for the three siting areas.

Volume IIB - Geotechnical Report Yuma Proving Grounds/ Luke-Williams Bombing and Gunnery Range (YPG/LWBGR).

Volume III - Recommended Geotechnical Field Investigations for the three DoD siting areas.

Volume IV - Environmental Assessment Report: Geotechnical Field Investigations for the three DoD siting areas.

The purpose of this investigation and general content of each of the volumes is contained in Section 1.2.

Large map and overlay graphics (with Explanation) were prepared for use with the four volumes cited above. The overlay graphics consist of fifteen base maps, designated Y-I through Y-XV (Figure 2), and seven overlays for each map with the exception of Y-V and Y-XI which are totally excluded and have one overlay. Titles of the overlays are:

1. Trench
2. Shelter and Pool
3. Hydrology
4. Soils Engineering
5. Geology
6. Topography

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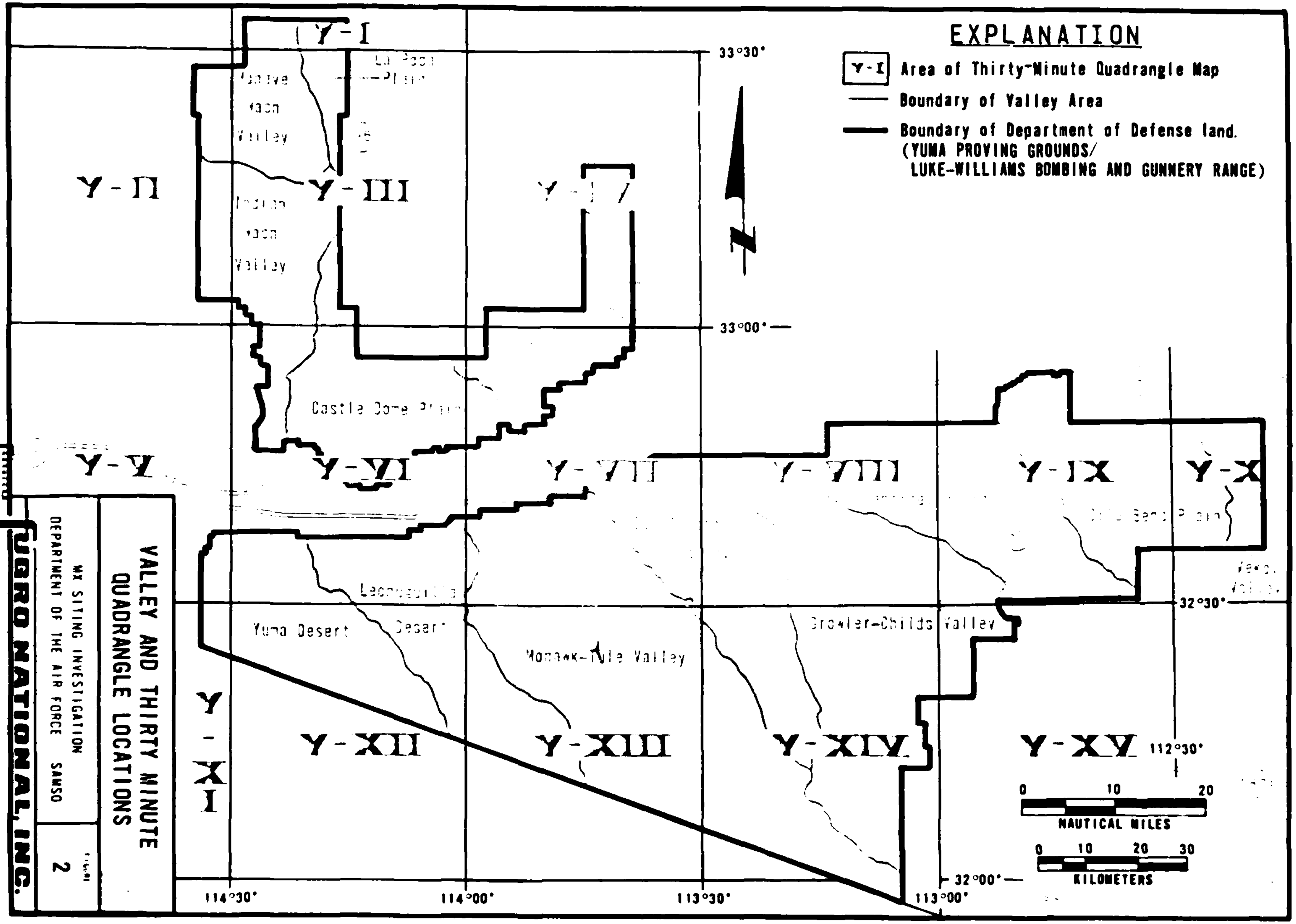

VALLEY AND THIRTY MINUTE QUADRANGLE LOCATIONS

MX SITING INVESTIGATION
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FIGURE 2

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7. Ownership and Cultural Features

The first two overlays show non-specific locations of shelters, pools (aim point system) and trenches (line system). The YPG/ LWBGR graphics have been divided and bound in five individual volumes, which are identified as follows:

Graphics Volume IIB-1 - (Includes Y-I; Y-II; Y-III)
Graphics Volume IIB-2 - (Includes Y-IV; Y-V; Y-VI)
Graphics Volume IIB-3 - (Includes Y-VII; Y-VIII; Y-IX)
Graphics Volume IIB-4 - (Includes Y-X; Y-XI; Y-XII)
Graphics Volume IIB-5 - (Includes Y-XIII; Y-XIV; Y-XV)

1.2 PURPOSE

The purpose of this phase of the study was to:

1. Collect and analyze available geotechnical and related data including:
   a. Geology and Seismology
   b. Topography and Terrain Analyses
   c. Soils and Soils Engineering
   d. Hydrology (surface and groundwater)
   e. Climatology
   f. Ownership and Cultural Features and Land Utilization

   For convenience, data for these categories are hereafter referred to as geotechnical data.
2. Report the results of data collection in a useful and informative format (Volumes IIA, IIB, IIC and overlays).

3. Locate potential sites for shelters, pools and trenches using judgement based upon the results of items 1 and 2 above and criteria developed with SAMSO for the non-excluded areas (Volume I).
4. Based on items 1, 2 and 3, determine in general what techniques and methods should be recommended for geotechnical field investigations in specific DoD areas (Volume III).
5. Collect and analyze selected environmental data to provide an environmental assessment of the potential impacts of the recommended geotechnical field investigations (Volume IV).
6. Evaluate and rank the DoD land areas from a geotechnical viewpoint according to their suitability for siting of the MX system (Volume I).

1.3 SCOPE

The scope of the study is presented in Tasks 1 through 10 of the "Program Plan for Geotechnical Services" prepared by Fugro National, Inc. (revised 13 November, 1974) in conjunction with SAMSO/TRW and includes:

1. Collection and analysis of available geotechnical data and selected environmental data (Tasks 1, 2, 3, 7 and 8);
2. Analysis of available aerial photographs (Tasks 2 and 3);
3. Brief ground and aerial reconnaissance of the YPG/LWBGR area to collect additional data and verify geotechnical

conditions determined during the literature research (Task 8);

4. Depiction of the data onto large and small graphics and written description of data within the text and on Data Summary Sheets (Tasks 4, 5, 6, 9 and 10);
5. Identification, evaluation and ranking of potential siting areas for the land mobile system (Task 10).

1.4 STUDY APPROACH AND METHODS

The collection and evaluation of existing geotechnical data from all available sources prior to commencement of field activities was a primary factor controlling the study approach. Data were collected from many agencies, institutions and individuals. Data collection activities included trips to Luke Air Force Base, Phoenix, Tucson, Yuma and Yuma Proving Grounds, Arizona; Menlo Park and Sacramento, California; Denver, Colorado; Vicksburg, Mississippi; and Midland, Texas.

Collected geotechnical data were evaluated to determine their specific applicability to siting parameters for the MX land mobile system before inclusion in any of the project reports. General and region-wide analyses, useful in the overall understanding of a siting area, were kept as limited as possible.

Although limited work has been compiled on YPG, a lack of specific data on LWBGR has necessitated the use of regional studies and extrapolation from specific studies of adjacent Bureau of Land Management (BLM) and other public or private land areas. The paucity of detailed geologic mapping of both

YPG and LWBGR dictated the use of aerial photographic interpretation to provide general information in areas of exposed rock and greater than ten percent grade, and detailed information in Valley areas. To date, only limited field check of the aerial photographic analysis of a small portion of YPG has been completed.

Compiled geotechnical data have been depicted primarily on base maps and overlays of the size defined by four fifteen-minute U.S. Geological Survey topographic maps combined into a thirty-minute map (also referred to as a four-quad sheet). Where fifteen-minute maps were not available, reductions of larger scale maps were made to obtain the 1:62,500 scale. Although much data were collected, they were not extensively depicted in those areas with surface gradient generally exceeding ten percent (Section 2.1.6) or areas defined by significantly large quantity-distance exclusions (Section 2.1.5). The relative locations of the fifteen four-quad sheets (Y-I through Y-XV) are shown on the small report graphics and on the topographic base maps. References in the text to specific overlays are by the title of the overlay followed by the appropriate Drawing number, e.g., (Geology, Y-I through Y-III).

Data depicted on the overlays were derived from general, regional and site-specific studies. All contacts separating distinct geologic or soils units are shown as solid lines representing data as they were collected from the literature or as interpreted from aerial photographs. Depth contours (Hydrology and Geology overlays) and boundaries of drainage

channels susceptible to flooding (Hydrology overlays) are dashed and dot-dashed, respectively, since some interpretation or refinement of the available data was necessary for the placement of the lines. These lines are queried where continuation of the data could not be made, or where extrapolation was uncertain.

Text discussion in the Geotechnical Report is limited mainly to introductory remarks, regional familiarization, qualifying statements and summary presentation. The text, small graphics and Data Summary Sheets (Section 3.0) supplement the overlays. The Data Summary Sheets aid in the interpretation and qualification of the data displayed on the overlays. In addition, they present data which cannot be easily displayed on the overlays and normally would be incorporated as extensive text.

Important to siting considerations are contiguity of and accessibility between land areas suitable for siting. The Valley Analysis Concept (Section 3.0) has been introduced to enhance data depiction and usability. A Valley (designated by capitalized "V") is a sub-area of the DoD siting area and may be composed of portions of one or more four-quad sheets for which geotechnical data may be compiled. It is bounded by one or both of the following:

1. A hydrologic drainage divide (most often the crest of an intervening mountain range), and
2. DoD boundary or any other artificially established boundaries such as public highways, township and

range lines, or national monument borders.

Typically, a Valley includes an alluvial lowland area and the flanks of its bordering mountain ranges. A geographic valley, as designated and named on existing maps, may encompass a portion of, or include the entire alluvial lowland area of a Valley. Most often Valley names correspond with the appropriate geographic valley name.

There are fourteen Valleys within YPG/LWBGR (Figure 2). The location and identification of each Valley and the Valley boundaries are depicted on 1:250,000 scale maps contained within the Valley Analysis (Section 3.0), on the four-quad base maps and on the small graphics. Valleys within YPG include:

1. La Posa Plain (3.3)
2. Mohave Wash Valley (3.4)
3. Indian Wash Valley (3.5)
4. Castle Dome Plain (3.6)
5. King Valley (3.7)
6. Palomas Plain (3.8)

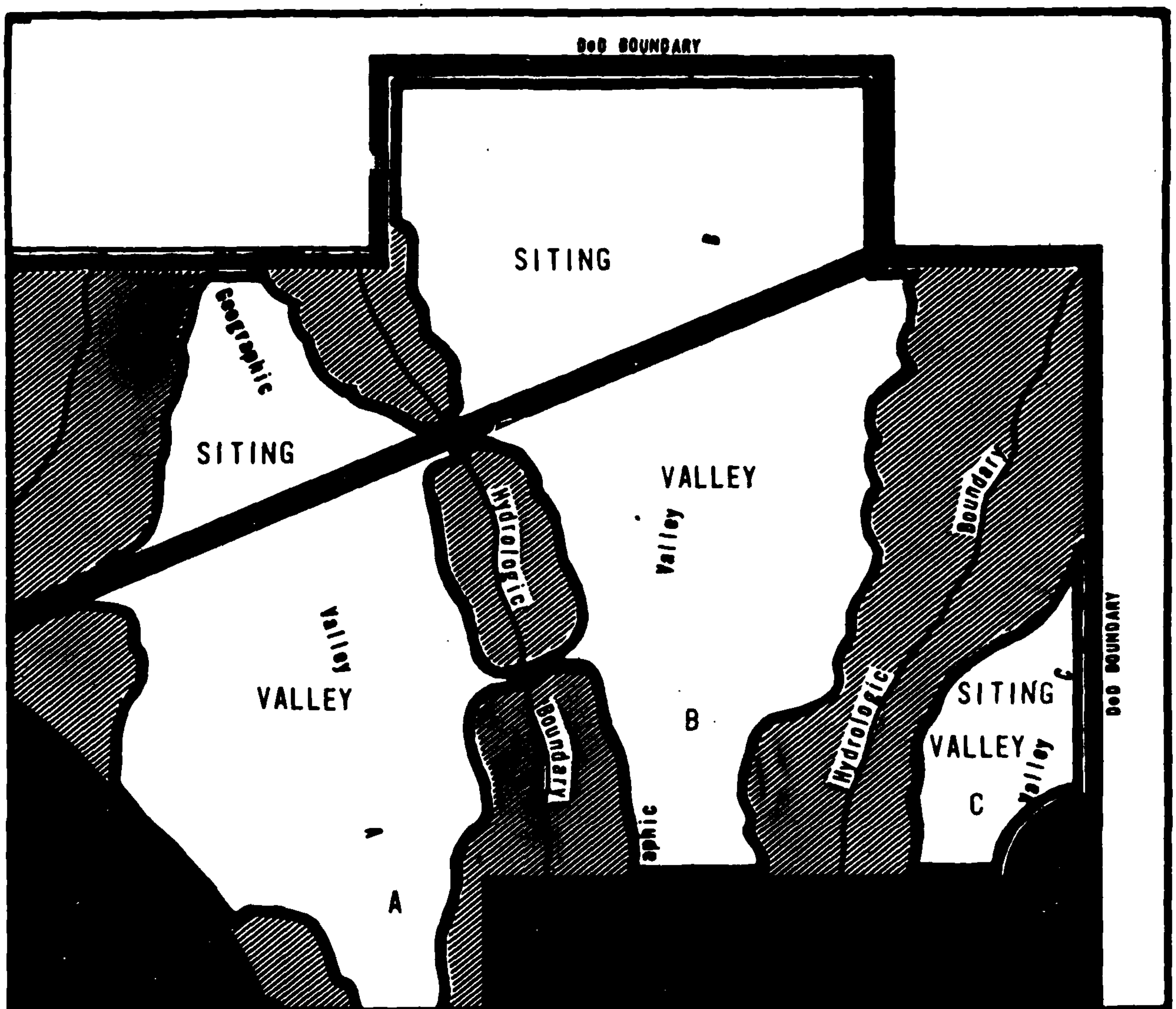
Valleys within LWBGR include:

7. Yuma Desert (3.9)
8. Lechuguilla Desert (3.10)
9. Mohawk-Tule Valley (3.11)
10. San Cristobal Valley (3.12)
11. Growler-Childs Valley (3.13)
12. Sentinel Plain (3.14)

13. Gila Bend Plain (3.15)

14. Vekol Valley (3.16)

The area within a designated Valley which is available for siting based only on cultural and quantity-distance exclusions (Section 2.1.5) and general topographic conditions (less than ten percent grade; Section 2.1.6) is referred to as the siting valley. The siting valleys within YPG/LWBGR are depicted in Figure 7 (Section 2.1.5) and in Sections 3.3 through 3.16. The relationships among Valleys, geographic valleys and siting valleys are depicted diagramatically in Figure 3.



EXPLANATION

PRIMARY QUANTITY-DISTANCE EXCLUSION

- Minimum distance from population centers.
- Minimum distance from DoD boundary and/or inhabited buildings
- Minimum distance from traveled public highway
- Excluded areas, e.g. national park, monuments, Indian reservation

SYMBOLS

- Area with greater than ten percent topographic grade
- Valley boundary
- Siting valley boundary

RELATIONSHIPS OF VALLEYS AND SITING VALLEYS TO GEOGRAPHIC VALLEYS

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE 3

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2.0 REGIONAL ANALYSIS

2.1 GEOGRAPHY AND DEMOGRAPHY

2.1.1 SITING AREA LOCATION AND DESCRIPTION

YPG/LWBGR is located in southwestern Arizona. YPG lies completely within southern Yuma County. LWBGR lies principally in southern Yuma County, with approximately one-third of the Range extending eastward into Maricopa and Pima Counties (Figure 4).

The Gila River Valley (largely non-DoD land) serves as a natural divide between the YPG and LWBGR portions of the siting area (Figure 4). There is no DoD land connecting YPG and LWBGR across this valley.

YPG/LWBGR is comprised of approximately 4,320 square nautical miles (nm^2). YPG comprises approximately 58 percent of the Yuma Test Station, a roughly rectangular area of approximately 1900 nm^2 that also includes the Kofa Game Range (745 nm^2) and Imperial National Wildlife Refuge (71 nm^2). The 1090 nm^2 included in YPG form a roughly "U"-shaped area with maximum continuous north-south and east-west dimensions of approximately 50 nautical miles (nm) and 40 nm, respectively (Figure 4). Approximately 40 nm^2 in the Muggins Mountains in southern YPG are under transfer to BLM (Figure 4). Elevations in YPG range from 175 feet at Yuma Test Station Headquarters to 2880 feet in the northern Chocolate Mountains.

The LWBGR is a roughly wedge-shaped area of approximately 3230 nm^2 extending east-west between Ajo and Yuma and includes the Cabeza Prieta Game Range (1020 nm^2). LWBGR has maximum

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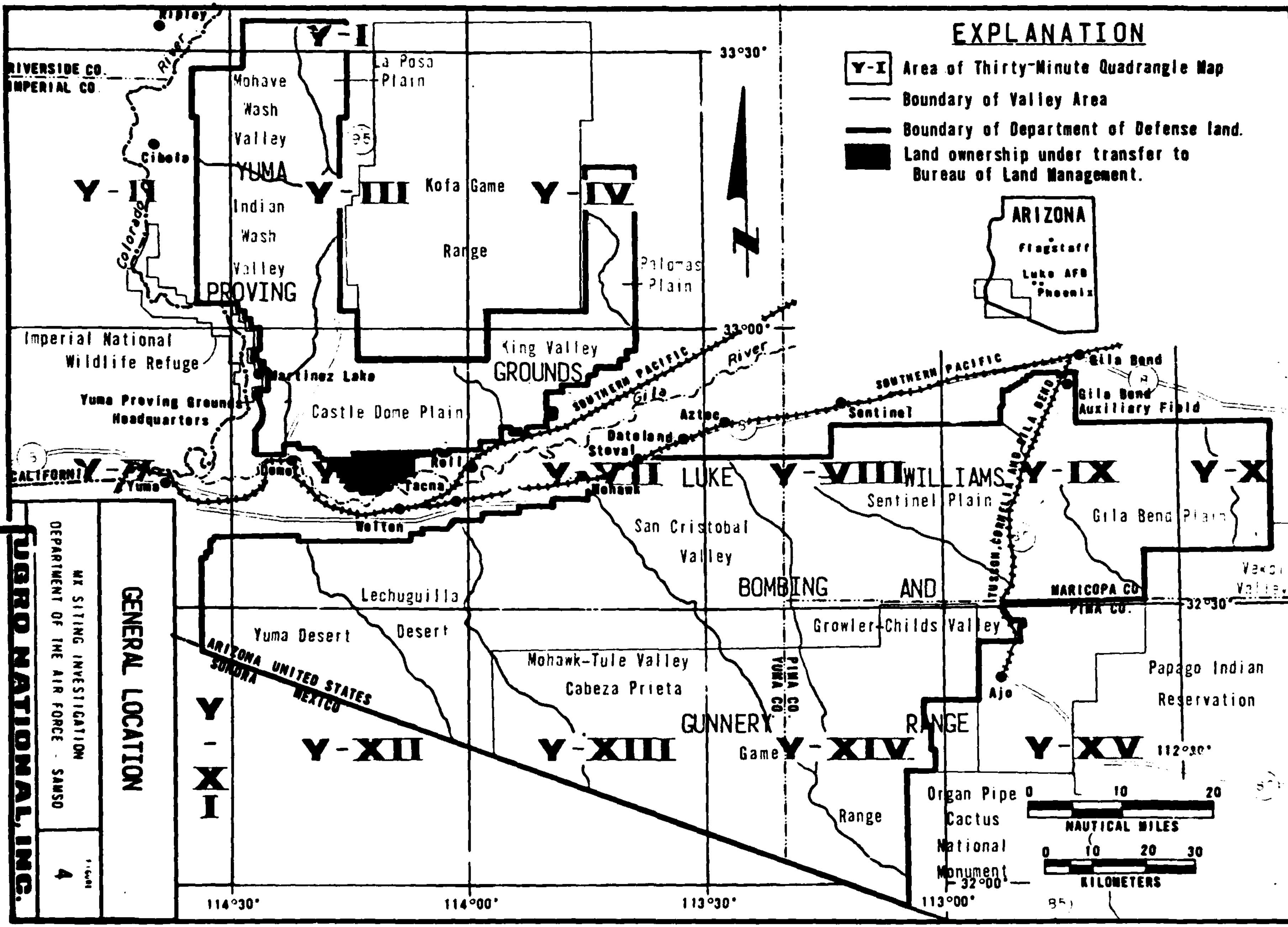

GENERAL LOCATION

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FIGURE 4

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continuous north-south and east-west dimensions of approximately 113 nm and 52 nm respectively (Figure 4). Elevations in LWBGR range from 200 feet in the western Yuma Desert to 4084 feet in the Sand Tank Mountains.

2.1.2 USES OF LAND AND SURFACE WATER

2.1.2.1 Land

Originally established in 1943, under the U.S. Army Corps of Engineers, YPG is the only U.S. Military general purpose proving grounds located in desert terrain. Reassigned to the U.S. Army Materiel Command in 1962, it provides facilities and technical services for the Signal Corps, Chemical Corps, Corps of Engineers and Ordinance Corps (Shepard and others, 1955; Anderson and Italia, 1970). YPG contains two range and test areas; these are only generally defined and lack specific, designated boundaries (H. F. Barnett, oral communication, 1975). The Cibola Range, or Automated Aircraft Armament Range, generally coincides with the non-rock portion of Indian Wash Valley (Section 2.2.3, Figure 9). Cibola Range is used for aircraft armament tests and for testing environmental exposure and function of chemical munitions. The Kofa Range is defined as that portion of YPG east of Firing Front Road including Castle Dome Plain, King Valley and Palomas Plain (Figure 4) and is used for munitions and weapons testing and ammunition storage. A third range, the North Cibola Range, has been proposed for anti-armor testing and will generally coincide with the non-rock portion of La Posa Plain (Section 2.2.3, Figure 9). Numerous vehicular test tracks are also present

within YPG. The Kofa Game Range and Imperial Wildlife Refuge are under Department of Interior supervision, and are jointly administered by the Bureau of Sport Fisheries and Wildlife, U. S. Fish and Wildlife Service and the BLM (U. S. Bureau of Sport Fisheries and Wildlife, 1974b).

Originally activated in February 1941 as part of the Litchfield Park Air Base, LWBGR served as a training site for pilots until deactivation in November 1946. Reactivated in February 1951 following the official designation of Luke Air Force Base (AFB), the Range remains under primary control of Luke AFB, near Phoenix, with Gila Bend Auxiliary Field providing combat and facilities support for training missions in LWBGR. LWBGR is sub-divided into eight bombing and gunnery ranges. The western sector is a radio-controlled Air-to-Air Range jointly administered with and used by the U. S. Marine Corps Air Station, Yuma, Arizona. The central area which is composed of the Air-to-Air Range, the North and South Applied Tactics Ranges, and Target 53, and the East Tactical Range are used primarily by the Tactical Fighter Training Wing from Luke AFB for air-to-ground combat exercises. LWBGR is also used for training pilots of the Federal Republic of Germany. The Cabeza Prieta Game Range is administered by the U. S. Bureau of Sport Fisheries and Wildlife (U. S. Fish and Wildlife Service) in cooperation with the BLM. In addition, small tracts, encompassing less than one percent (40 nm^2), are leased by the state and by private individuals within DoD administered land (U. S. Bureau of Land Management, 1968).

Land ownership of areas surrounding YPG/LWBGR boundaries is divided into federal, state, and private (U.S. Bureau of Land Management, 1968). The majority of land surrounding YPG/LWBGR is under federal control, including BLM lands, Organ Pipe Cactus National Monument, Papago Indian Reservation, Imperial National Wildlife Refuge, and the Kofa Game Range. Land along the Gila River Valley and bordering LWBGR on the west is divided among BLM, state and private ownership. LWBGR is bounded on the south by the international border between the United States and Mexico.

2.1.2.2 Surface Water

There are no known perennial surface water occurrences within the YPG/LWBGR boundaries (Shepard and others, 1955; Ross, 1922a, 1922b, 1923). The only important occurrences of surface water in the vicinity of YPG/LWBGR are along the Colorado and Gila Rivers and their respective canal systems. The sources for these waters are outside DoD lands and the water rights are apparently held by the surrounding communities and/or ranches. Surface water conditions within YPG/LWBGR are discussed in Section 2.4.

2.1.3 POPULATION AND POPULATION DISTRIBUTION

The population within YPG/LWBGR is largely transient and consists primarily of military, civil service, and contractual personnel totaling approximately 2000. Population in YPG is centered at the Yuma Test Station Headquarters, and approximately 200 military and civilian personnel are located at the Gila Bend Auxiliary Field in LWBGR. The population centers adjacent to YPG/LWBGR, with their population and distance from the nearest

range boundary, are listed in Table 1. Civilian transient population includes visitors to the Imperial Dam Recreation area, persons traveling through DoD land along U.S. 85 and 95, and limited visitors to the Cabeza Prieta Game Range.

2.1.4 CULTURAL IMPROVEMENTS

Access to YPG/LWBGR is provided by U.S. 85 from Ajo to Gila Bend, Arizona and U.S. 95 from Yuma to Quartzsite, Arizona. Numerous improved dirt roads and unimproved jeep trails lead away from these highways and from Interstate 8 and U.S. 80 from Yuma to Gila Bend into various portions of YPG/LWBGR. Camino del Diablo and a border patrol road, both improved dirt roads, are parallel and adjacent to the southern boundary of LWBGR. However, all access to military facilities and installations within YPG/LWBGR is strictly controlled by the military. Travel on the public highways which traverse YPG/LWBGR is generally uncontrolled, but at times may be restricted.

Railroads include the Tucson, Cornelia and Gila Bend Railroad, which extends north along U. S. 85 from Ajo to Gila Bend, and, adjacent to YPG/LWBGR, the Southern Pacific Railroad from Yuma extending northeast to Gila Bend and Phoenix (Figure 4).

A major electrical transmission line owned and maintained by the U.S. Bureau of Reclamation originates in Yuma and generally parallels U.S. 95 (Stubbs and Moore, 1963) which traverses YPG in a northerly direction (Figure 5). Another major electrical transmission line parallels U.S. 85 which traverses LWBGR

TABLE 1

Population Centers

Population Center*	Population**	Distance from Range
Yuma, Arizona	29,007	5.0 nm
Ajo, Arizona	8,000	4.0 nm
Blythe, California	7,047	7.1 nm
Gila Bend, Arizona	2,500	2.5 nm
Wellton, Arizona	970	2.5 nm
Palo Verde, California	610	7.2 nm
Quartzsite, Arizona	600	7.2 nm
Tacna, Arizona	595	2.0 nm
Ehrenberg, Arizona	400	3.9 nm
Roll, Arizona	80	3.8 nm
Dateland, Arizona	50	2.0 nm
Aztec, Arizona	50	3.5 nm
Sentinel, Arizona	35	2.0 nm
Martinez Lake, Arizona	10	0.2 nm
Dome, Arizona	10	1.7 nm
Cibola, Arizona	10	3.9 nm

*Locations shown on Figure 4.

**All population figures based on 1970 census (U.S. Census Bureau).

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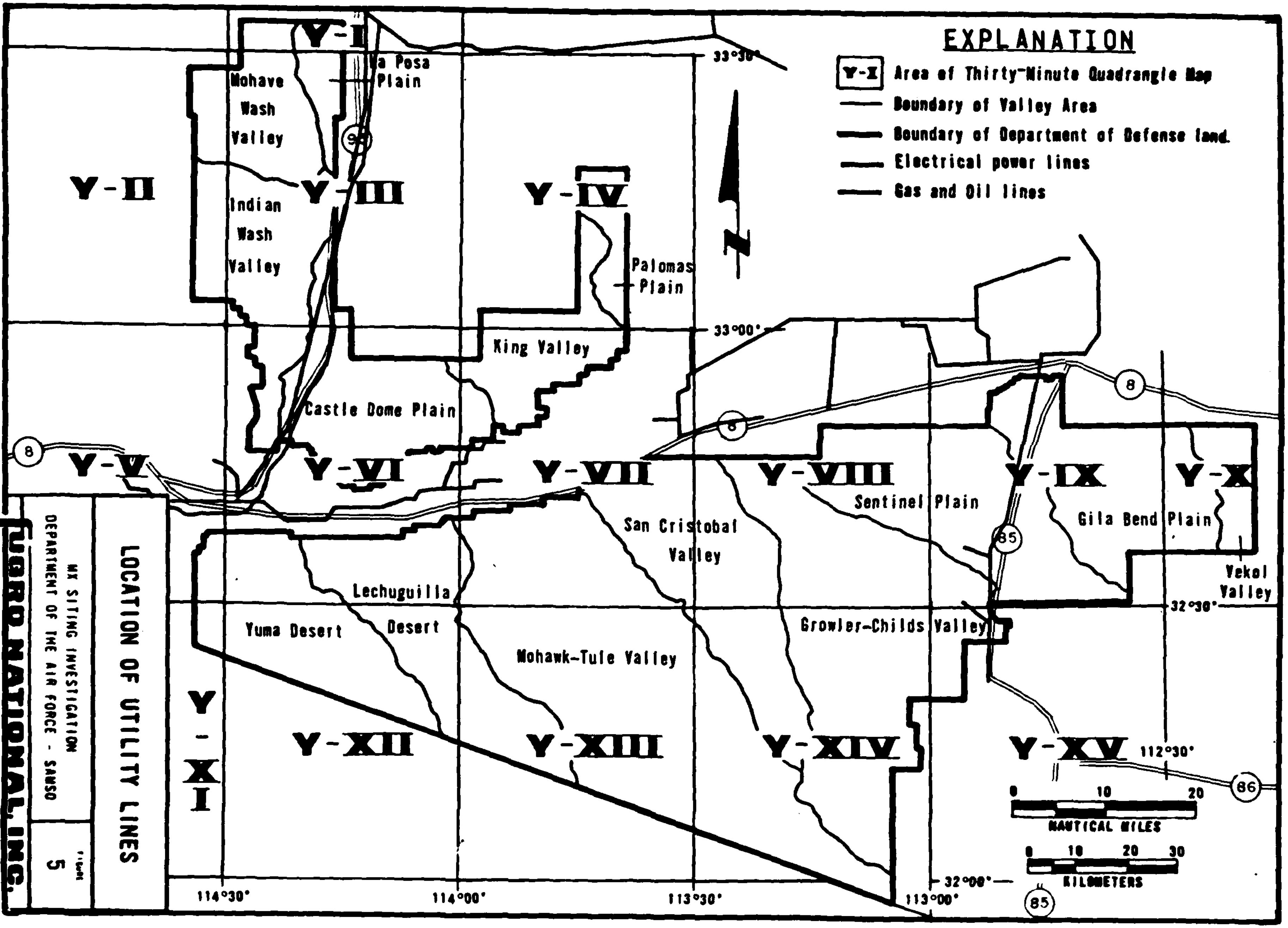

LOCATION OF UTILITY LINES

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FIGURE 5

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between Ajo and Gila Bend (Lower Colorado River State-Federal Interagency Group, 1971). Two small networks of transmission lines extending from Yuma and Gila Bend provide service to the Gila River Valley area adjacent to YPG/LWBGR (Stubbs and Moore, 1963). A buried gas line and a buried oil pipeline owned and operated by El Paso Natural Gas Company originate in Yuma and generally parallel U.S. 95 (Stubbs and Moore, 1963), traversing YPG. Besides these utilities which are primarily for civilian use, electrical transmission and telephone systems are present at Yuma Test Station Headquarters in YPG, and at Gila Bend Auxiliary Field and Ranges #1 and #2 and along U.S. 85 in LWBGR.

Water canal systems adjacent to YPG/LWBGR include the Gila Main Canal along the Colorado River, and the Dome and Wellton-Mohawk Canals in the Gila River Valley (Figure 6).

Several permanent and semi-permanent instrumentation sites, test sites, target areas, abandoned airstrips and military contaminated areas are scattered throughout YPG/LWBGR. The locations of these areas and more information about them, where known, are presented on the Ownership and Cultural Features overlays and Data Summary Sheets.

2.1.5 CULTURAL AND QUANTITY-DISTANCE EXCLUSIONS

The major cultural and quantity-distance exclusions which limit siting areas within YPG/LWBGR are depicted on the appropriate overlays and include:

1. An 18 nm arc from Yuma, Arizona (Figure 7);

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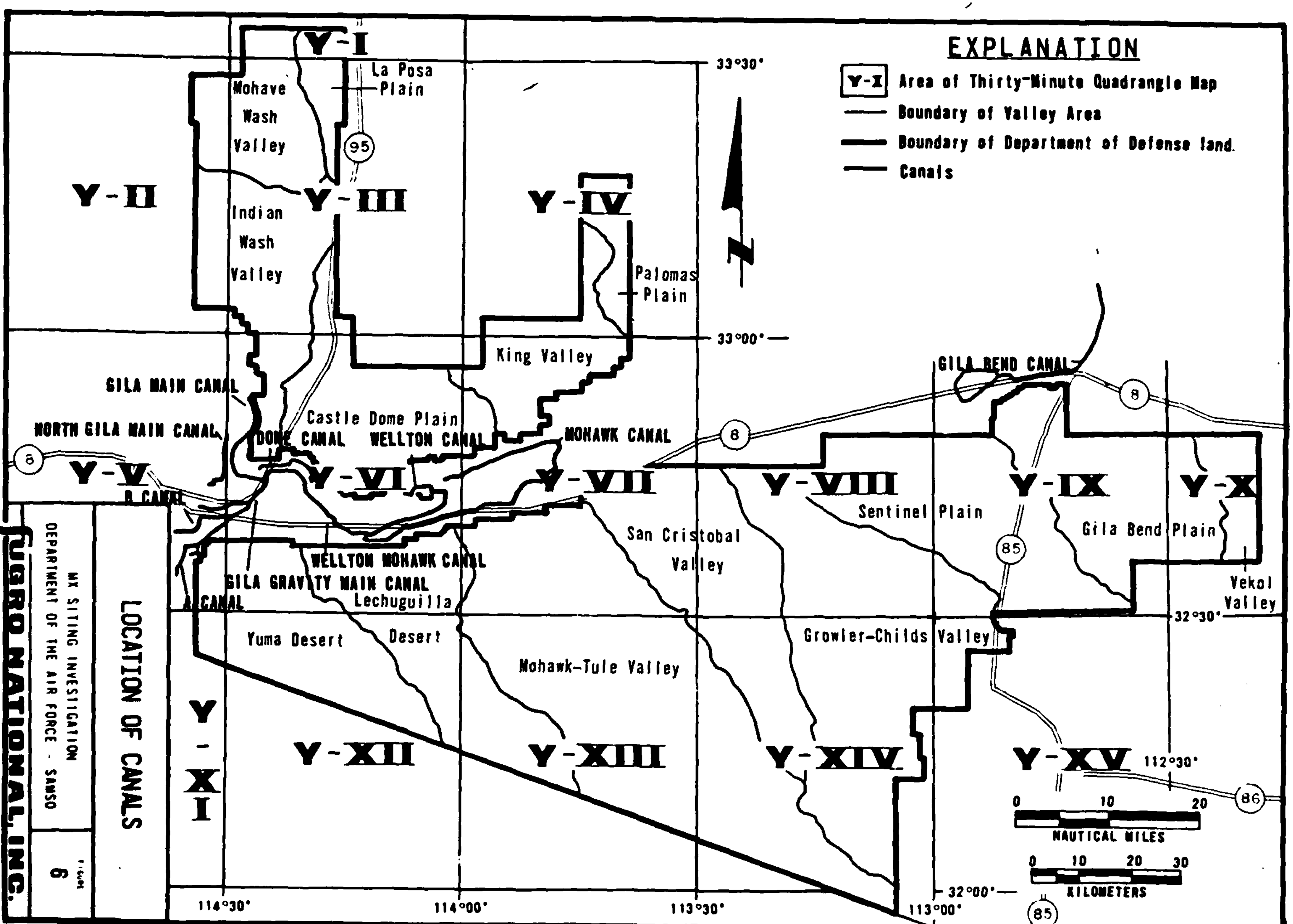

LOCATION OF CANALS

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FIGURE 6

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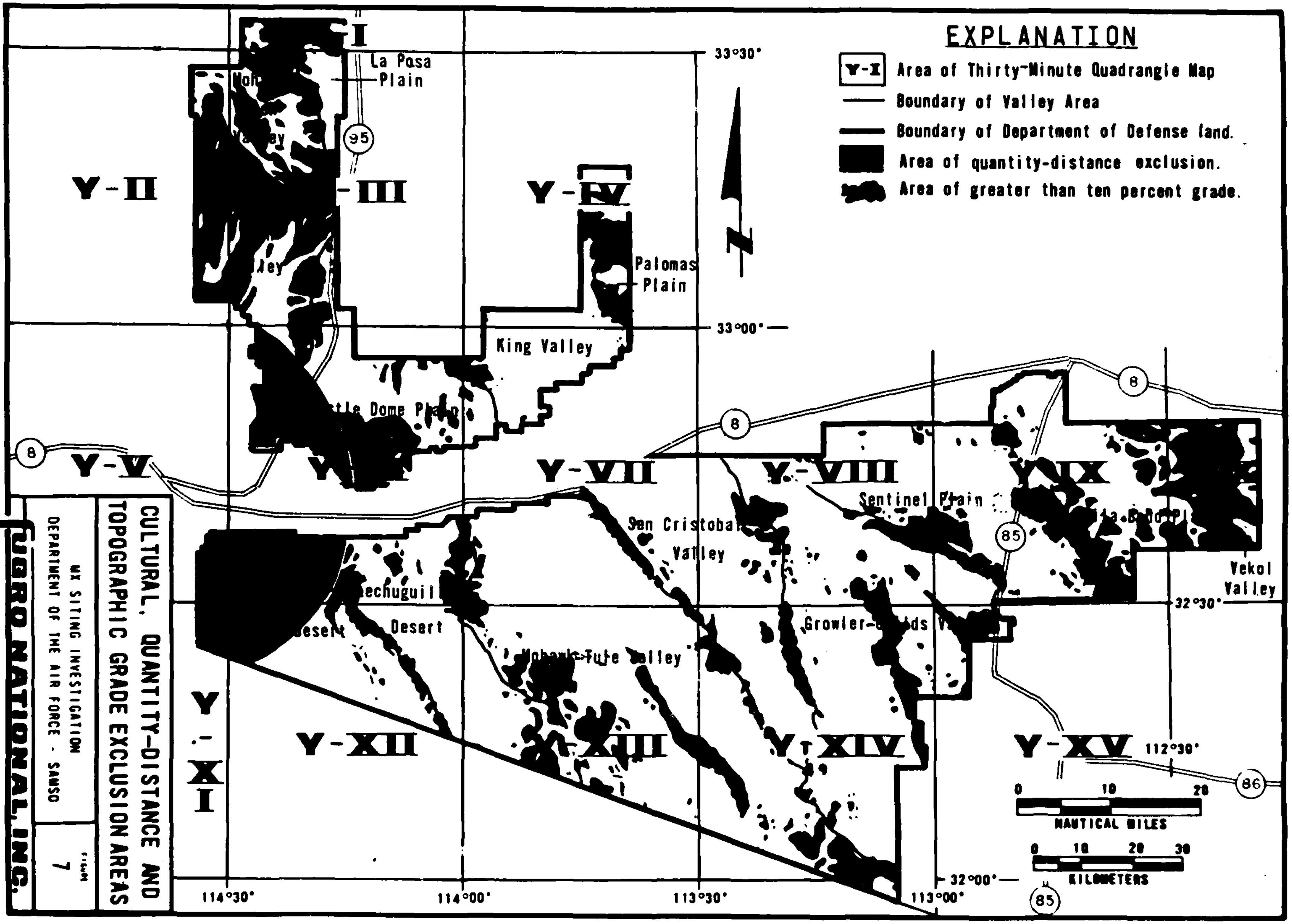

CULTURAL, QUANTITY-DISTANCE AND TOPOGRAPHIC GRADE EXCLUSION AREAS

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FIGURE 7

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2. A corridor, 2965 feet wide, inside and parallel to the boundary of YPG/LWBR; and
3. Corridors, 1780 feet wide, on each side of Highway 95 in YPG and Highway 85 and the Tucson, Cornelia and Gila Bend Railroad in LWBGR.

In addition, the following minor quantity-distance and cultural features were identified within YPG/LWBGR, but are not believed restrictive to siting:

1. Several small buildings whose locations were determined primarily from topographic maps. Field examination of several of these features showed them to be abandoned.
2. Numerous permanent and semi-permanent military instrumentation and monitoring sites which are inhabited on a periodic basis.

2.1.6 GENERAL TOPOGRAPHIC CONDITIONS AND EXCLUSIONS

General topographic conditions for the various landforms present in the siting area are expressed in terms of topographic grade. The principal criterion for the exclusion of an area from siting considerations is the greater than ten percent topographic grade ($5^{o}43'$, 528 feet/mile). In YPG this condition occurs primarily in areas of exposed rock (Section 2.2.3.2) in the mountains and hills, and also includes the topographically higher, older alluvial fan surfaces. In LWBGR areas of greater than ten percent grade include exposed rock in the mountains and hills, the topographically higher portions of the alluvial fans and pediment surfaces adjoining exposed rock, and locally

on steep leeward slopes of sand dunes.

A transition zone of five to ten percent grade ($2^{o}52'$ to $5^{o}43'$, 264 to 528 feet/mile) occurs immediately adjacent to the areas of greater than ten percent grade. Small mappable areas of five to ten percent grade occur sporadically in areas of exposed rock and the topographically higher portions of the alluvial fans in YPG/LWBGR. In LWBGR, this also includes most of the Pinacates Volcanic field and the Sentinel Flow, both areas of volcanic flow rock (Section 2.2.3.2, Figure 9).

In YPG, the zero to five percent grade range (0 to $2^{o}52'$; 0 to 265 feet/mile) encompasses the younger alluvial fans, the topographically lower portions of the older alluvial fans, and wash areas (Section 2.2.2.6). In LWBGR, the zero to five percent topographic grade range encompasses essentially all of the valley areas. Landforms which predominate in this grade range include alluvial fans and washes. In addition, sand dunes, playas, and small areas of exposed rock are also present within this grade range.

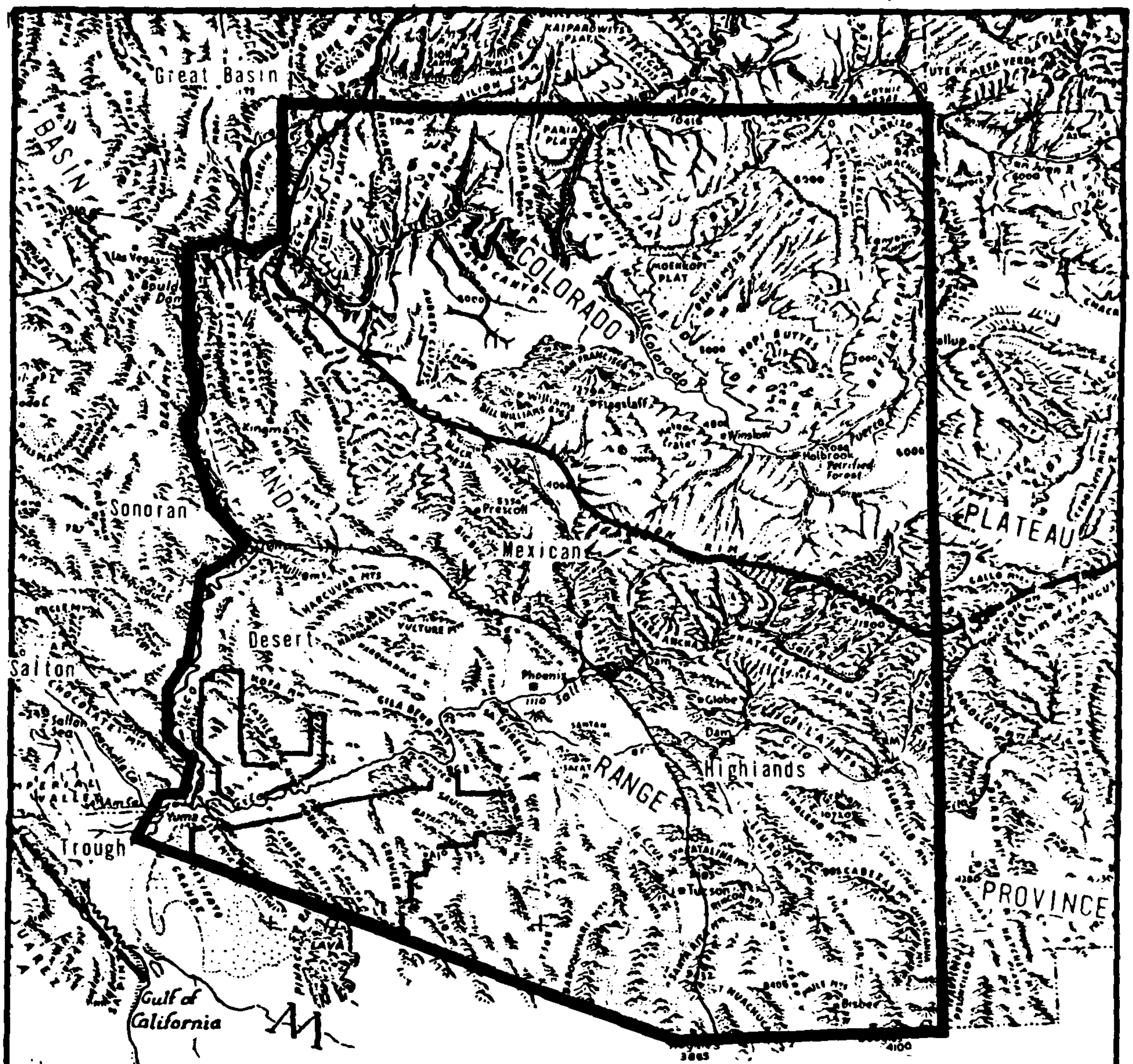
The ten percent topographic grade exclusion combined with the cultural and quantity-distance exclusion (Section 2.1.5) accounts for approximately thirty-three percent (1407 nm^2) of the total area of YPG/LWBGR and comprises the total area excluded from siting consideration (Figure 7). Of the remaining area, approximately 57 nm^2 is included in the five to ten percent topographic grade range and approximately 2856 nm^2 in the zero to five percent range.

2.2 GEOLOGY

2.2.1 GENERAL

YPG/LWBGR lies mainly within the Sonoran Desert section of the Basin and Range Physiographic Province (Heindl and Lance, 1960). The Yuma Desert west of the Algodones fault is within the Salton Trough section of the Basin and Range Physiographic Province (Mattick and others, 1973; Olmsted and others, 1973) (Figure 8). The physiography is controlled by, and therefore strongly reflects, the underlying geologic structure. This area is characterized by eroded remnants of uplifted fault-block mountains (horsts) separated by downdropped basins (grabens) (Millet and Barnett, 1970). Unlike the major portion of the Basin and Range Province, this is an area of predominantly open-basin conditions and through-flowing drainages. Valleys within YPG/LWBGR include La Posa Plain, Mohave Wash Valley, Castle Dome Plain, King Valley and Palomas Plain in YPG, and Yuma Desert, Lechuguilla Desert, Mohawk-Tule Valley, San Cristobal Valley, Growler-Childs Valley, Sentinel Plain, Gila Bend Plain, and Vekol Valley in LWBGR (Figures 2 and 4).

In YPG, the mountain ranges are irregular in shape and generally trend west to northwest with granitic and metamorphic basement rock dominant in the southern half of the area and volcanic bedrock dominant in the northern half of the area (Table 2; Figure 7). Indian Wash Valley, Castle Dome Plain and King Valley drain southward toward the Gila



EXPLANATION

- Boundary of Department of Defense land.
- Boundary of Physiographic Province. Dashed where approximate.
- Section boundary of Physiographic Province. Dashed where approximate.

0 50 100
NAUTICAL MILES

0 50 100
KILOMETERS

N

MODIFIED AFTER. Fenneman, 1946

PHYSIOGRAPHIC DIVISIONS OF ARIZONA

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FIGURE 8

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DATE 30 JUNE 1975

TABLE 2

Dominant Rock Type in Mountains

Mountain Range	Dominant Rock Type*
In YPG	
Dome Rock Mountains	V and S Bedrock
Trigo Peaks	V Bedrock/M Basement
Trigo Mountains	V Bedrock/M Basement
Chocolate Mountains	V Bedrock
Middle Mountains	G and M Basement
Castle Dome Mountains	V Bedrock/G Basement
Muggins Mountains	G and M Basement
Red Bluff Mountain	V Bedrock
Palomas Mountains	V Bedrock/G Basement
Tank Mountains	V Bedrock
In LWBGR	
Gila Mountains	G and M Basement
Tinajas Atlas Mountains	G Basement
Copper Mountains	G and M Basement
Cabeza Prieta Mountains	V Bedrock/G Basement
Sierra Pinta	G and M Basement
Mohawk Mountains	M and G Basement
Bryan Mountains	G Basement
Agua Dulce Mountains	M Basement
Aguila Mountains	V Bedrock
Granite Mountains	G Basement
Growler Mountains	V Bedrock
Crater Range	V Bedrock
Childs Mountain	V Bedrock
Sauceda Mountains	V Bedrock
Sand Tank Mountains	V Bedrock/M Basement

*V=Volcanic; S=Sedimentary; G=Granitic; M=Metamorphic; /=Overlying

River and southwestward toward the Colorado River. These valleys provide the largest basin-fill area connected by passes and plains of less than ten percent grade within YPG (Figure 7).

In LWBGR, the mountain ranges are generally linear with a northwest trend. Granitic and metamorphic basement rocks are dominant in the western ranges, volcanic bedrock in the central ranges, and volcanics overlying granitic rocks in the eastern ranges (Table 2; Figure 7). The intervening basins generally drain northward to the Gila River, except locally in the south-central portion of LWBGR where internal drainage into small playas has developed, or where drainage is to the south toward Mexico. All basin-fill areas between the Gila Mountains on the west and the Sand Tank Mountains on the east are connected by passes and plains of less than ten percent grade (Figure 7).

2.2.2 GEOMORPHIC SETTING AND SURFICIAL GEOLOGY

2.2.2.1 General

For at least the past thirty million years (Appendix B) these basins have been filled by deposits which are the products of wind, water and gravity erosion of the surrounding mountains (Olmsted, 1968). Basin-fill deposits present at the surface can be associated with various geomorphic features, including (in order of decreasing abundance) alluvial fans and bajadas (A5), pediments (A6),

playas (A4), sand dunes (A3), and terraces (A2) (Appendix B). These landforms provide the basis for relating the distribution and nature of the surficial deposits and terrain to the suitability for siting the MX system.

The basin-fill deposits are primarily coarse-grained, with lesser fine-grained sediments attaining a cumulative thickness of greater than 10,000 feet in the northern end of Mohawk-Tule Valley (proprietary information, 1974) and the southern Yuma Desert (Mattick and others, 1973). However, they are probably no more than 200 feet thick in the western portions of the YPG (H. F. Barnett, oral communication, 1974). Measured seismic (compressional wave) velocities in the basin-fill deposits range from an average of 7500 feet per second (fps) for unconsolidated to semi-consolidated deposits to an average of 13,000 fps for well-cemented fanglomerate (Barnett, 1975, in press; Mattick and others, 1973). The high average seismic velocity (7500 fps) for the unconsolidated deposits probably reflects the presence of units possessing varying degrees of cementation (i.e., with caliche). Layers with lower seismic velocities are probably also present within the basin fill.

Caliche is a secondary accumulation of calcium carbonate (Pope, 1971) often present as a competent binding and cementing agent in the near-surface exposures of the oldest fans. Some calcium carbonate can be found in most soil profiles throughout southwestern Arizona (Chamberlain,

1974); however, the degree of development varies with local conditions. Calichified intervals may also be present at depth within the basin-fill deposits.

Determination of the nature of these deposits is based on limited data derived from investigations performed primarily by the U. S. Geological Survey, the U. S. Army Corps of Engineers, Yuma Proving Grounds, and U. S. Army Natick Laboratories. Field investigations included limited rotary drilling and sampling, test pit excavation and geophysical surveys (gravity, aeromagnetic, seismic refraction and reflection, and resistivity). Our investigators conducted a brief ground (YPG) and aerial (fixed-wing at YPG, helicopter with landings at LWBGR) field reconnaissance, and aerial photographic analysis.

2.2.2.2 Alluvial Fans and Bajadas

Alluvial fans are the predominant geomorphic feature in YPG/LWBGR, encompassing approximately 67 percent (1950 nm^2) of the total area of the siting valleys. They occur along the flanks of all mountain ranges as wedge-shaped deposits less than a few tens of feet thick at the mountain front and up to several hundreds of feet thick in the basins.

At least three generations of alluvial fans are present in YPG/LWBGR. They are identified as $A5_T$, $A5_{QT}$, and $A5_Q$ (Appendix B) to indicate relative ages within YPG and LWBGR, but not to imply necessarily that they are correlative

between the two areas, or even between valleys, although that may be the case. In general, the older and topographically higher fans occur nearer the mountain fronts and are moderately dissected and more deeply incised (Table 3) than the more basinward, younger fan units. These alluvial fan units consist of poorly sorted, sub-angular boulders, cobbles and gravels, with sand and silt becoming more dominant further from the mountain front.

TABLE 3

Degree of Drainage Dissection and Incision

Drainage Density (no. streams per nm)		Depth of Drainage Incision (average in feet)	
Slight	0-5	Shallow	0-5
	6-10		6-10
Moderate	11-15	Moderate	11-15
	16-20		16-20
High	> 20	Deep	> 20

The oldest alluvial fans ($A5_T$) generally are preserved as small fan remnants which have their greatest areal extent near the Muggins Mountain in YPG (Geology, Y-VI and Y-VII). These fan deposits generally are topographically higher than the younger alluvial fans, are moderately dissected, deeply incised, have well-rounded ridge crests, may be covered by desert pavement, and appear to be isolated from their source

area. They are Tertiary in age (Lance, 1960), but cannot easily be differentiated from Tertiary fanglomerate (well-cemented fan) without field checking. The oldest fan deposits, therefore, also include cemented fanglomerate. Along the east flank of the Gila Mountains (LWBGR) (Geology Y-VI) and in the vicinity of the Muggins Mountains (YPG), the oldest fan deposits also include portions of the Kinter Formation, a mid-Tertiary fanglomerate with basal sedimentary strata (sandstones, shale, limestones) and thin interbeds of volcanic and sedimentary material (Wilson, 1933; Lance and Wood, 1958; Lance, 1960; and Olmsted and others, 1973). Although these deposits are more extensive in YPG than LWBGR, their geomorphic expression is consistent throughout both areas. The $A5_T$ fans encompass an estimated one percent of the siting valley area within YPG/LWBGR.

The intermediate generation of fans ($A5_{QT}$) are more extensive than the $A5_T$ fan deposits throughout YPG/LWBGR encompass an estimated 25 percent of the siting valleys. However, geomorphic expression of $A5_{QT}$ within YPG is different than that within LWBGR. In YPG, the $A5_{QT}$ deposits are more extensive than the $A5_T$ or the youngest ($A5_Q$) fan deposits. In general, these deposits either flank the mountain ranges as high, complex ridges averaging one to two nm in width and extending up to seven nm from the mountain front, or occur as isolated ridge segments. Topographically, the $A5_{QT}$ deposits are represented by at least

three distinct minor topographic levels that are, as a whole, distinctly intermediate in elevation between the $A5_Q$ and $A5_T$ fan deposits. Typically, in YPG, the $A5_{QT}$ deposits are moderately dissected with semi-rounded ridge crests covered by nearly continuous desert pavement (a thin residual on lag gravel resulting from removal of finer particles by wind or water) consisting of gravel to cobble-size material possessing a well-developed desert varnish (a thin mineralized patina or coating of iron and manganese oxides).

In LWBGR, with the exception of the area south of the Agua Dulce Mountains and along the flanks of the Sauceda and Sand Tank Mountains, the surface of $A5_{QT}$ deposits appear to represent an "exhumed" calichified level with the original overlying fan surface material eroded away. In general, the $A5_{QT}$ deposits discontinuously flank the mountain ranges, but may be present several miles from the mountain front as isolated remnants. They possess only minor topographic expression and generally shallow incision, and appear to be graded to approximately the same base level as the younger alluvial fans ($A5_Q$). South of the Agua Dulce Mountains (Geology, Y-XIV) and along the flanks of the Sauceda and Sand Tank Mountains (Geology, Y-IX and Y-X) the $A5_{QT}$ deposits are more extensive than elsewhere in LWBGR. The $A5_{QT}$ fans are topographically higher than the youngest fans ($A5_Q$) and, south of the Agua Dulce Mountains, are topographically lower than the oldest fan deposits

($A5_T$). They are moderately dissected, with rounded ridge crests covered by well-varnished desert pavement and, in general, are graded to the same base level as the pediments in these two areas.

The youngest alluvial fan deposits ($A5_Q$) possess distinctive geomorphic expression within YPG and LWBGR. The $A5_Q$ fans are actively aggrading in both YPG and LWBGR, and encompass an estimated 75 percent of the siting valleys. In YPG the $A5_Q$ deposits generally begin at the mountain front or within areas of $A5_{QT}$ deposits, and extend basinward as moderately dissected linear areas, generally one to two nm in width, flanked by the $A5_{QT}$ fan deposits. $A5_Q$ deposits in turn generally flank the modern washes. Interfluvial areas of $A5_Q$ fan surfaces are relatively flat and typically covered by a desert pavement of pea-size gravel with poorly developed desert varnish. The $A5_Q$ deposits are topographically lower than the two older fan generations, and are characterized by at least three distinct minor topographic levels. Locally, the $A5_Q$ deposits may coalesce, such as along the margin of La Posa Plain (Geology, Y-I and Y-III); however, a well-developed bajada is lacking.

In LWBGR, the $A5_Q$ fans coalesce forming broad gently sloping alluvial fan surfaces, or bajadas, that grade from areas of exposed rock, pediment or older fans to the axial portion of the valleys. A coarse-grained facies of these and related deposits ($A5c_Q$ and $A5c_u$), where the surface is

estimated to be greater than 70 percent gravel, is generally found nearer the mountain fronts (Geology, Y-VI through Y-X, Y-XII through Y-XV) and exhibits deeper drainage incision than the fine-grained fan deposits. Coarse-grained material (gravel, cobbles and boulders) with similar geographic distribution in the shallow subsurface was observed during a brief field reconnaissance. Incision is generally shallow, ranging from six feet near the mountain front to less than one foot in the central portions of the valley. Interfluvial areas are covered by a discontinuous desert pavement of pea-size gravel with scattered cobble-size material with poorly developed desert varnish.

2.2.2.3 Pediments and Pediment Deposits

Pediments, as defined for this study, are represented by planated rock shelves generally overlain by a thin mantle (less than ten feet thick) of sand- to boulder-size residual or alluvial material (pediment deposits: A6). The pediment surfaces are slightly to moderately dissected with incision generally less than five feet and commonly serve as surfaces of sediment transport. As mapped from aerial photographs, pediments extend a maximum of seven nm from the mountain front, or, where overlain by alluvial fan deposits nearer the mountain front, appear is isolated remnants. Pediments were mapped in LWBGR along the flanks of the Sand Tank (Geology, Y-IX and Y-X), Sauceda (Geology, Y-IX and Y-X), Agua Dulce (Geology, Y-XIV) and Copper Mountains (Geology,

Y-VII and Y-VIII) encompassing approximately 67 nm^2. Field reconnaissance revealed the existence of pediments on the southwest flank of the Palomas Mountains (YPG; Y-IV and Y-VII) and on the east flank of the central Sierra Pinta Mountains (LWBGR; Y-XIII), but their extent could not be mapped using aerial photographs without the aid of further field analysis. Byran (1925) suggests the presence of pediments along the flanks of Baker Peaks (Geology, Y-VI and Y-VII) along the southwest flank of the Cabeza Prieta Mountains (Geology, Y-XIII), and at the northern end of the Gila Mountains (Geology, Y-VI); however, the existence of these pediments could not be verified by aerial photographic analysis or during field reconnaissance.

2.2.2.4 Playas

Playas are the lowest areas within enclosed desert drainage basins generally characterized by almost horizontal vegetation-free surfaces of fine-grained sediments that are periodically inundated (Cooke and Warren, 1973). Playas ($A4_Q$) in YPG/LWBGR are present in the southern portion of Mohawk-Tule Valley (Geology, Y-XIII and Y-XIV) and include Las Playas, Dos Playas, and Pinta Playa, and an unnamed playa in central Growler-Childs Valley (Geology, Y-VIII). Other limited areas of ponded drainage exist but lack true playa characteristics. These include areas south of the Sentinel Basalt Flow (Geology, Y-VIII and Y-IX) and west of the Pinacates Volcanic Field (Geology, Y-XIII) where

drainages are dammed by the basalt flows.

Generally small (less than one nm^2), the playas are characterized by medium- to fine-grained sediments deposited at the margins of the alluvial fans. Thus, they are probably underlain by a sequence of interbedded lacustrine and fine-grained alluvial sediments (Krinsley and others, 1968). The generally deep groundwater table in this area suggests that these playas discharge only surface water derived from run-off or direct precipitation. Therefore, they may have a high clay content and an accumulation of calcium carbonate, but the proportion of saline material is probably low (Cooke and Warren, 1973).

The present limits of the playas are well known topographically and geographically, encompassing a total of less than two nm^2. However, fluctuations in climatic conditions in the geologic past may have produced intertonguing of the various alluvial units resulting in sequences of coarse- and fine-grained materials alternating vertically and horizontally in the subsurface (Appendix C). The presence of fine-grained silt and clay layers with dispersed saline material (gypsum) in the subsurface in King Valley (Geology Y-IV and Y-VII) in YPG (U. S. Army Corps of Engineers, 1972a; Air Force Weapons Lab, 1973) and the occurrence of playa deposits in other similar basins in Arizona (Feth, 1964; Kister and Hardt, 1966; Koester, 1972b; Pierce, 1973) suggest the existence of playa deposits at depth within YPG/LWBGR.

2.2.2.5 Wind-Blown Sand

Wind-blown sand deposits ($A3_Q$) are found within YPG/LWBGR. Two semi-stable dune fields ($A3d_Q$) are present in LWBGR: (1) the Mohawk Dunes along the west flank of the Mohawk Mountains (Geology, Y-VII) encompass approximately 20 nm^2, and (2) the Fortuna Dunes in the Yuma Desert (Geology, Y-XII) encompass approximately eight nm^2 with local relief of 20 to 30 feet (Olmsted and others, 1973). Large sheets of sand ($A3s_Q$) are associated with these major dune fields and may contain local areas of presently active mobile dunes. These sands were primarily derived by deflation of Cenozoic Colorado River sediments to the southwest of LWBGR (Norris and Norris, 1961; Merriam, 1969; Olmsted and others, 1973; Arvidson and Mutch, 1974). The Pinta Sands, a large sand sheet with local areas of small dunes, encompass approximately seven nm^2 surrounding the Pinacates Volcanic Field in south-central Mohawk-Tule Valley (Geology, Y-XIII and Y-XIV).

Shepard and others (1955) state that there are no dunes within the limits of Yuma Test Station. However, subdued, stabilized, linear sand dunes were observed in YPG during a brief field reconnaissance and aerial photographic analysis and are reported in recent literature (Millet and Barnett, 1970). These dunes are located in the vicinity of Yuma Test Station Headquarters, within the 18 nm exclusion arc from Yuma (Ownership and Cultural Features, Y-VI). Barnett

(1975, in press) describes these dunes as being individually oriented northwesterly, generally about 500 feet apart with a mean relief of 2.2 feet and maximum lengths of two miles. An area of man-made sand dunes is located just west of U. S. 95 near the southern boundary of YPG. These are composed of fine-grained basin-fill material, bulldozed into dune form (Shepard and others, 1955) for use in vehicular testing programs.

2.2.2.6 Stream Channel and Undifferentiated Floodplain Deposits

Stream channel (wash) deposits (Al_Q) encompassing approximately 190 nm^2, are composed of loose sand, gravel, silt and minor amounts of clay. The dominant grain size depends on the volume of water discharged by the stream, rates of flow, channel configuration, source material, and grain size of the material traversed. Wash deposits average five to ten feet thick, with a maximum of approximately 30 feet (Olmsted, 1972). In YPG, with the exception of King Valley and La Posa Plain where drainage is principally rill wash or sheet flow, the stream channels are typically flat-floored, and have 45^{o} to near-vertical banks. Linear drainages vary in width from a few feet to more than one nm, with incision averaging about five feet and reaching a maximum of approximately 20 feet. In LWBGR, primary drainage channels are generally shallowly incised, except in the eastern portion of the range where they are typically

incised to a depth of five to eight feet. Tributary drainages are generally moderately incised (five to ten feet) nearer the mountain fronts, becoming shallower (less than three feet) toward the axial portion of the basin.

2.2.2.7 Terraces

Terraces are topographic benches within a river valley that usually represent former levels of the valley floor or floodplain. In YPG/LWBGR the terraces ($A2_Q$) are related to the Colorado and Gila Rivers. Terrace deposits of the Gila River are present along the southern margin of the YPG (Geology, Y-VI and Y-VII) and the western half of the northern boundary of LWBGR (Geology, Y-VII). The surficial distribution of these Gila River terrace deposits is quite limited within the YPG/LWBGR boundaries; however, they may be more extensive in the subsurface, buried beneath a mantle of alluvial fan material that grades toward the Gila River.

Terrace deposits of the Colorado River are present along the western flank of the Gila Mountains in LWBGR (Geology, Y-VI, Y-XI, and Y-XII) becoming more extensive nearer the River. In YPG, the Colorado River terrace deposits are present near the Yuma Test Station Headquarters (Geology, Y-VI) (Olmsted, 1972). These deposits, too, have limited surficial distribution, are buried by alluvial fan deposits, and may be more extensive in the subsurface, although total

thickness of the terrace deposits is unknown. Terrace deposits, typically well sorted sand, silt and gravel (Shepard and others, 1955) encompass approximately 35 nm^2 (less than two nm^2 of the siting valley) of YPG/LWBGR; however, most of this area is contained within the 18 nm exclusion arc around Yuma.

2.2.3 ROCK CONDITIONS

2.2.3.1 General

For this study, material considered as rock can be subdivided into three categories; these include bedrock, basement rock and volcanic flow rock (Appendix B). In general, each of these three rock types possess distinctive characteristics of importance for MX siting considerations, such as seismic response, blast effects, or the nature of basin-fill deposits derived from them.

The first category, termed bedrock, includes competent volcanic and sedimentary rocks (including fanglomerates) which commonly have seismic velocities (p-wave) of 10,000 to 20,400 fps in the Yuma area (Mattick and others, 1973) and are be ieved to represent the range of bedrock seismic velocities throughout YPG/LWBGR (Barnett, 1975, in press).

The second category of rock is basement rock, consisting of crystalline igneous (granitic) and metamorphic rock (gneisses and schists), with seismic velocities of 14,000 to 16,000

and 17,000 to 18,000 fps, respectively. Basement rock in the Yuma area commonly underlies bedrock and basin-fill materials (Mattick and others, 1973). Basement rocks, because of their basal stratigraphic position in the geologic record, generally infer great age (Precambrian through Cretaceous; Appendix B). The granite, gneiss and schist are pre-Tertiary in age (Olmsted, 1972; Olmsted and others, 1973; Dillon and Haxel, 1975). Available radiometric age dates of 1440 million years (m.y.) (Olmsted and others, 1973) and 73 m.y. (Wasserburg and Lanphere, 1965) suggest that original crystallization occurred in the Precambrian with a subsequent metamorphic event in the Cretaceous.

The third category, volcanic flow rock, is restricted to extrusive igneous rocks, generally basaltic in composition, which are commonly flat-lying, geologically young (Quaternary or Quaternary-Tertiary) and overlie, or are interbedded with basin-fill materials.

2.2.3.2 Exposed Bedrock, Basement Rock, and Volcanic Flow Rock

Exposures of bedrock units, exceeding thicknesses of 1000 to 2000 feet, occur primarily in northern YPG and eastern LWBGR mountain areas where topographic grades exceed ten percent (Section 2.2.1, Table 2; Figure 9). Bedrock exposures with limited areal extent occur within areas of lesser topographic grade. In order of decreasing abundance,

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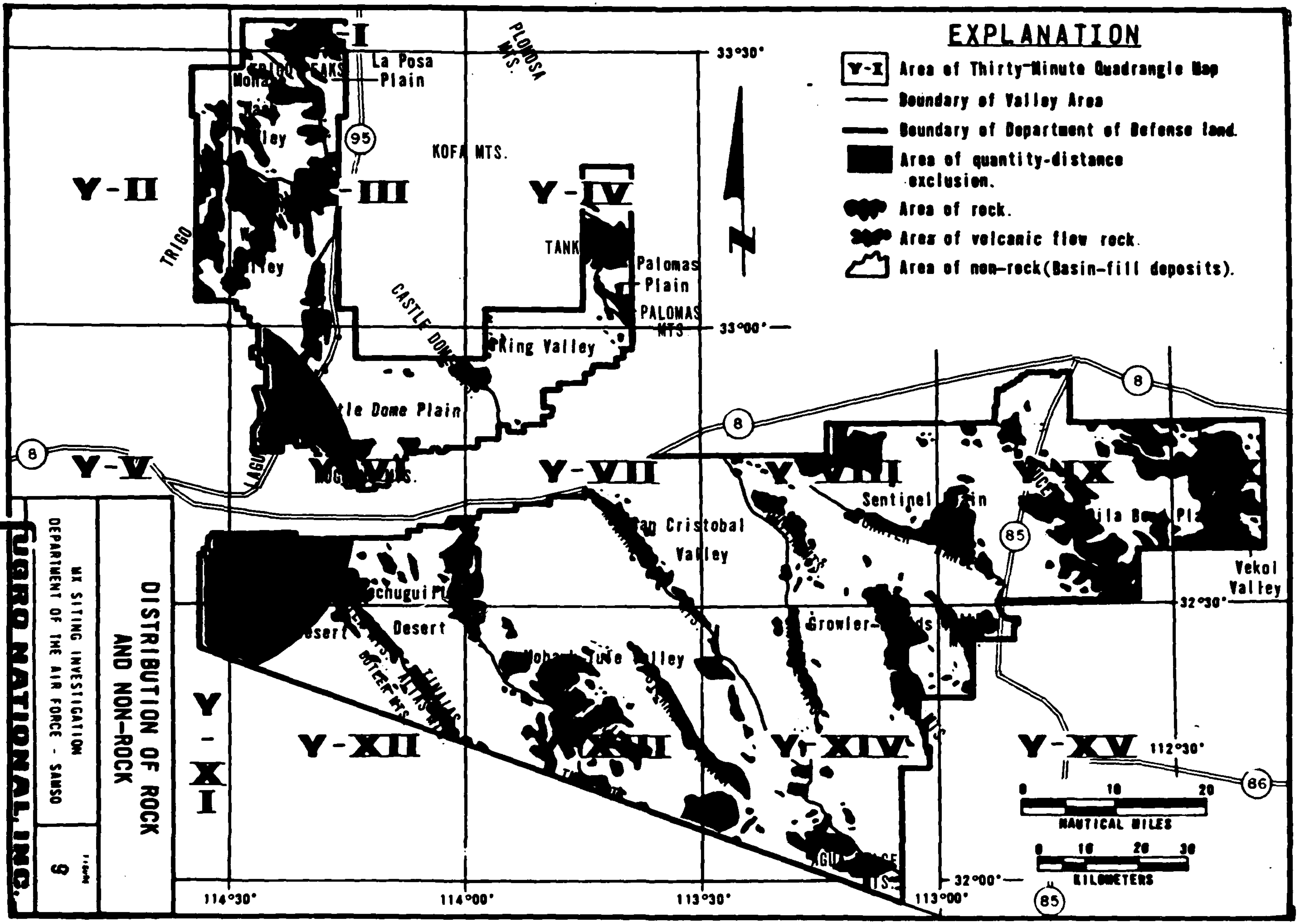


DISTRIBUTION OF ROCK AND NON-ROCK

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE 9

FUGRO NATIONAL, INC.

the bedrock units consist predominantly of volcanic rocks composed of pyroclastic and flow rocks ranging in composition from rhyolite to basaltic andesite, and sedimentary rocks composed primarily of sandstone, siltstone and conglomerate (Bryan, 1925; Barnett, 1975, in press).

Granitic and metamorphic basement rocks, primarily granitic, gneissic and schistose and lesser amounts of metasedimentary rocks are exposed in southern YPG, western LWBGR and easternmost LWBGR (Section 2.2.1, Table 2; Figure 9).

The largest exposure of volcanic flow rock is the Sentinel Basalt Flow which overlies basin-fill deposits and extends into the Sentinel Plain (Geology, Y-VIII and Y-IX) in the north-central portion of LWBGR. This flat-lying basalt encompasses approximately 25 nm^2 of LWBGR. Portions of the flow have been dated as early Quaternary in age (1.71 $\pm$ 0.25 m.y.; Fugro, 1974).

A second large volcanic flow, overlying basin-fill deposits in southern Mohawk-Tule Valley (Geology, Y-XIII and Y-XIV), is a portion of the Pinacates Volcanic Field which is extensively exposed in Mexico. This flat-lying basalt flow occupies approximately 12 nm^2 of LWBGR. Portions of the field in Mexico were active less than 1000 years before present (b.p.) (Ives, 1956). These flows generally have rough surfaces and are composed of multiple flow units.

The presence of such young basalt flows on the surface suggests that other flows are present in the subsurface; this is substantiated by well log data (Section 2.4.2; Figure 12; Well 32; J. F. Ashley, written communication, 1975). The combined area of both exposures of volcanic flow rock totals less than one percent (37 nm^2) of the total surface area of YPG/LWBGR (Figure 9).

An estimated 25 percent (1080 nm^2) of the total area (4320 nm^2) within YPG/LWBGR consists of bedrock, basement rock and volcanic flow rock, with the remaining 75 percent (3240 nm^2) composed of basin-fill deposits (Figure 9). In YPG, approximately 32 percent (350 nm^2) of the total area (1090 nm^2) consists of exposed rock with the remaining 68 percent (740 nm^2) composed of basin-fill deposits. In LWBGR, approximately 23 percent (730 nm^2) of the total area (3230 nm^2) consists of exposed rock with the remaining 77 percent (2500 nm^2) composed of basin-fill deposits.

2.2.3.3 Subsurface Rock Conditions

Depth to bedrock and basement rock within YPG/LWBGR ranges from zero (surface exposures near the mountain fronts) to greater than 10,000 feet in the northern Mohawk-Tule Valley (proprietary data, 1974) and west of the southern Gila Mountains (Mattick and others, 1973). Geologic sections (R'-R", S'-S", T'-T", U'-U"; Appendix I) depict the

subsurface distribution of units where specific data are available.

Little is known about the composition and distribution of the subsurface rock. Water wells generally do not penetrate rock which underlies the basin-fill deposits. The limited well data available indicates the presence of volcanic bedrock, granitic basement rock, and volcanic flow rock in the subsurface.

Depth to rock has been contoured within YPG/LWBGR (Air Force Weapons Lab, 1973); however, well log data, observations made during field reconnaissance and aerial photographic analysis indicate some refinement of those contours is necessary. Determinations similar to those made by Air Force Weapons Lab (1973) can be derived using regional geophysical surveys (Turner, 1960; Sauck and others, 1971; Sauck, 1972; West, 1972; West and Sumner, 1973; and Aiken and Sumner, 1974) which suggests the Valleys within YPG/LWBGR are deep basins. Prominent gravity anomaly lows suggesting deep basins generally appear to correspond with structural lows interpreted from magnetic anomalies (Sumner and Aiken, 1973). However, these surveys depict only the regional configuration rather than local variations in rock distribution within the basins. Depth to rock contours (Geology, Y-I through Y-IV, Y-VI through Y-X, Y-XII through Y-XV) reflect interpretation of geo-

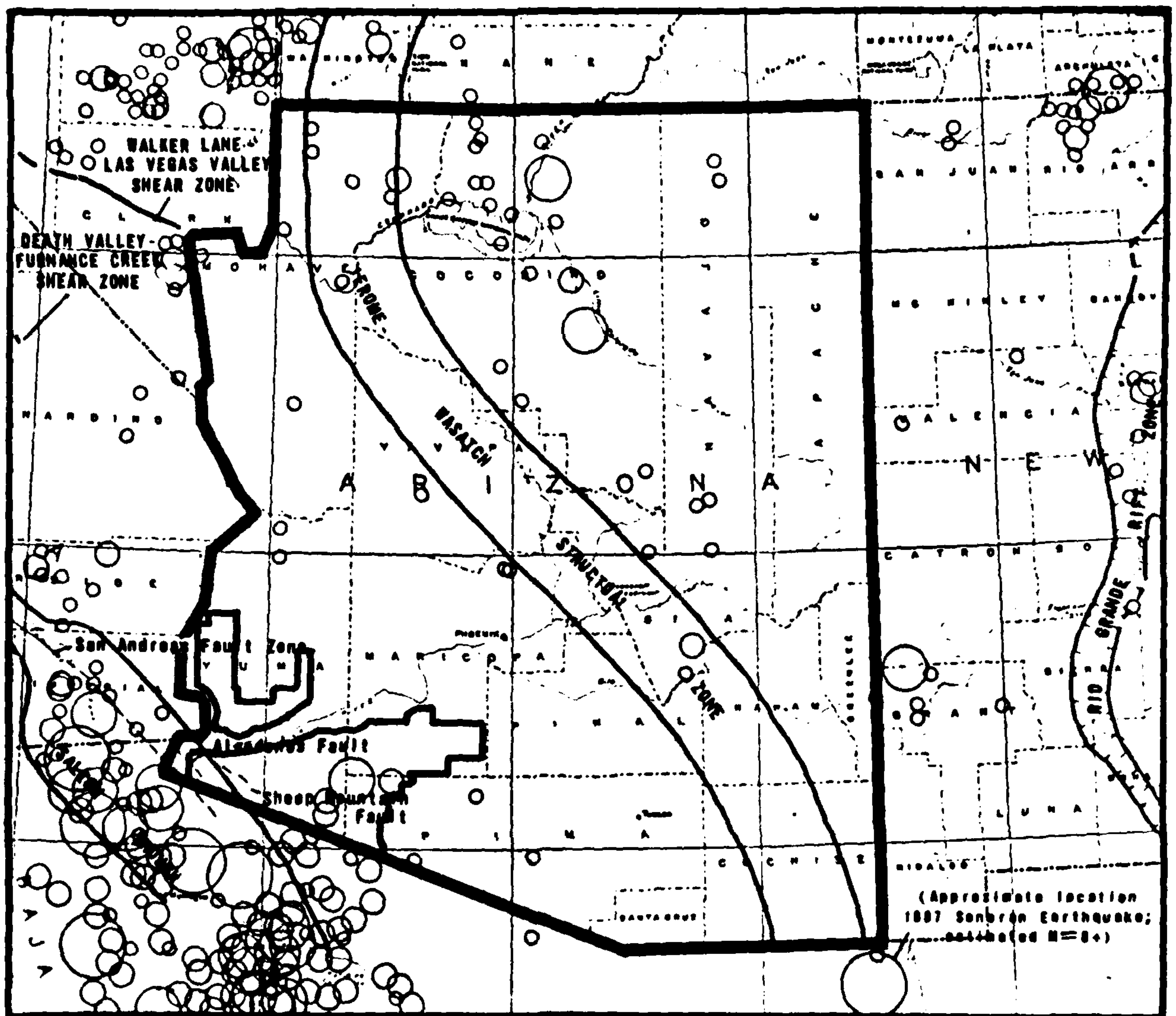
physical studies tempered by well log data and observations made during aerial photographic analysis and a brief field reconnaissance. Although contours are drawn for depths to 2000 feet, reliability of information decreases with depth and in areas lacking well control.

2.2.4 SEISMO-TECTONIC SETTING

2.2.4.1 Regional Setting

YPG/LWBGR lies within two major geologic provinces, the Gulf of California (Salton Trough) and the southern Basin and Range (Figure 10). The Gulf of California Structural Province is a complex, northwest-trending depression (Elders and others, 1972; Lomnitz and others, 1972) developed approximately four million years ago (Sharp, 1972). According to plate-tectonics theory, this is an active area of crustal spreading along the East Pacific Rise and transform faulting on the San Andreas shear zone (Atwater, 1970). The Salton Trough, the on-land extension of the Gulf of California Province (Biehler and others, 1964), corresponds with a portion of the San Andreas shear zone, which locally includes the San Jacinto, San Andreas and the Algodones faults.

The Basin and Range Structural Province is characterized by northwest-trending uplifted blocks (horsts) and down-dropped basins (grabens) bounded by normal faults (Christiansen and Lipman, 1972; Lipman and others, 1972).



EXPLANATION

EARTHQUAKE EPICENTERS

- M < 4.0
- M = 4.0 - 4.9
- M = 5.0 - 5.9
- M ≥ 6.0

0 50 100 150
NAUTICAL MILES

0 100 200
KILOMETERS

SYMBOLS

- Boundary of Department of Defense land.
- Approximate trend of structural element.
- Quaternary fault lines.

DATE: 30 JUNE 1975

SEISMO-TECTONIC FEATURES

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE 10

FUGRO NATIONAL, INC.

These bou·.dary faults occur within continuous zones or as en echelon structures with displacements ranging from tens to several thousands of feet (Wilson and Moore, 1959). Although major deformation occurred during early Mesozoic to Tertiary time (Appendix B), zones of active seismicity and Quaternary faulting occur within this province. The major elements of the Basin and Range Structural Province include the Jerome-Wasatch structural zone, the Walker Lane-Las Vegas Valley shear zone, and the Death Valley-Furnace Creek shear zone. Major elements of the Gulf of California and the Basin and Range Structural Provinces are summarized in Table 4. The principal elements that may affect YPG/LWBGR are discussed in the following sections.

2.2.4.1.1 Principal Seismo-Tectonic Elements of the Gulf of California Structural Province

The San Andreas fault is the most active single element within the San Andreas shear zone, and can be traced from the northwest to the east shore of the Salton Sea where the surface trace has been obscured by surficial deposits (Crowell, 1962). Based on the following evidence, the San Andreas fault may project into the southwest corner of the Yuma Desert adjacent to LWBGR: (1) alignment of gravity lows (Biehler, 1964), (2) aeromagnetic anomalies (Biehler and others, 1964), (3) presence of three recognizable fault traces at the surface (Babcock, 1971), and (4) two geothermal anomalies (Blake and others, 1973) which align with the projected trace of the fault.

TABLE 4
Seismo-Tectonic Elements

Element (Structural Province)	Closest Approach to the LWBGR (and Direction)	Total Length, Width or Area (Trend)	Age of Last [illegible] (10^4 years b.p.)			Remarks
			Faulting	Volcanism	Seismicity	
San Andreas Shear Zone (Gulf of California and others)	Transects south-west portion of Yuma Desert (LWBGR)	Approx. [illegible]0 nm in length, 30 to 120 nm in width (N40W)	Less than 1	None	Historic and recorded	Right lateral strike-slip faulting. Numerous M=6+ events in Gulf of California Province. Few M=8+ in northerly provinces. Capable fault system.
San Andreas fault (Gulf of California and others)	Approx. 50 nm (west)	Approx. 50 nm in length (N45W)	Less than 1	None	Historic and recorded	Right lateral strike-slip faulting. Numerous M=6 to 7 events. Few in Gulf of California province. Possible southward extension. Capable fault.
Algodones fault (Gulf of California)	Transects south-west portion of Yuma Desert (LWBGR)	Approx. 60 nm in length (N40W)	Approx. 200	None	No historic or recorded	Right lateral strike-slip fault. 3-5 feet displacements measured in paleosol horizon. Fault trace generally concealed. Potentially capable fault.
Pinacates Volcanic Field (Gulf of California)	Extends into south-central Mohawk-Tule Valley (LWBGR)	11 nm^2 in LWBGR of approx. 450 nm^2 total area.	Quaternary on associated faults.	24 (dated) less than 11 (est.)	Historic and recorded	Seismicity (M=4 to 5); associated with Quaternary faults in area.
Jerome-Wasatch Structural Zone (Basin and Range)	Approx. 60 nm (east)	Greater than 200 nm in length, 25 to 50 nm in width (N40-45W)	Less than 10	None known	Historic and recorded	Quaternary faulting in north-central Arizona. Events of M=5 to 5.6. Potentially capable zone.
Walker Lane-Las Vegas Shear Zone (Basin and Range)	Approx. 157 nm (north-north-west)	Greater than 275 nm in length, 1 to 10 nm in width (N50W to N20W)	Less than 1	Greater than 2,000	Historic and recorded	Right lateral faults. Events of M=4 to 5 at closest approach. Capable zone.
Death Valley Furnace Creek Shear Zone (Basin and Range)	Approx. 140 nm (northwest)	Approx. 160 nm in length, 1 to 10 nm in width (N45W)	Less than 1	None known	Historic and recorded	Right lateral faults. Events of M=4 to 6. Capable zone.

The Algodones fault is generally obscured by surficial deposits; however, the following evidence (Olmsted and others, 1973) defines its existence in the Yuma Desert: (1) presence of a 30- to 60-foot high escarpment in the older basin-fill deposits, (2) the existence of a groundwater barrier with an associated displacement of the water table of 30 feet, (3) a steep magnetic and gravity gradient, and (4) groundwater temperature anomalies. Seismic reflection profiles suggest possible parallel or en echelon faults (Mattick and others, 1973) in the vicinity of the Algodones fault. Shallow exploratory trenching across the Algodones fault revealed offsets of three to five feet in subsurface paleosoil units estimated to be approximately 200,000 years old (Woodward-McNeill, 1974a).

2.2.4.1.2 Principal Seismo-Tectonic Elements in the Southern Basin and Range Structural Province

The Death Valley-Furnace Creek shear zone (Stewart and others, 1962) is well defined in Death Valley (Figure 10) and has been inferred by Hunt (1963) and Hamilton and Myers (1966) to extend southeastward through the Parker-Blythe area at the California-Arizona border. However, recent detailed investigations (Davis and others, 1974; Fugro, 1974a; Woodward-McNeill, 1974a, b) reveal that the Death Valley-Furnace Creek shear zone does not extend farther southeast than the Garlock fault; this intersection occurs in the Avawatz Mountains approximately 140 nm northwest of YPG/LWBGR.

A minor structural element, the Gila Lineament in the Basin and Range Structural Province, is a northeast-trending trough (graben) that essentially parallels and encloses the Gila River Valley. The Gila Lineament extends northeast from the Gila Mountains through the crystalline basement rock and apparently pre-dates Basin and Range tectonic activity. While this lineament is not known to have associated Cenozoic faulting, it is coincident with a series of Tertiary-Quaternary volcanic fields including the Sentinel Basalt Flow (Section 2.2.3.2).

The Texas Lineament (Albritton and Smith, 1956), another minor structural element, is a poorly defined, diffuse structural zone postulated to extend northwest from the Trans-Pecos area of Texas across New Mexico and into southern Arizona (Wertz, 1970). This lineament is defined by pre-Quaternary faulting and an apparent alignment of copper mineralization (Mayo, 1958). Hunt (1963) suggests an alignment of the Texas Lineament and Walker Lane-Las Vegas shear zone, however he points out that the geologic and geophysical basis for the projection is very vague.

2.2.4.2 Structural Geology of YPG/LWBGR

2.2.4.2.1 Faults

The Algodones, Sheep Mountain and several unnamed faults (Geology, Y-VI and Y-XII) have been identified as capable faults (Appendix D) within LWBGR. Conservatively,

the U. S. Nuclear Regulatory Commission (formerly the U. S. Atomic Energy Commission) definition for capable faults was utilized due to the presence of nuclear components within the MX system and the potential for damage to the system by seismic activity or ground rupture.

The major characteristics of the Algodones fault and its relationship to YPG/LWBGR are defined in Table 4. By analogy with other faults in the San Andreas Shear Zone, the Algodones fault is assumed to possess a predominant strike-slip component. Offsets of gravity anomalies and reversals in direction of throw along the strike of the fault, similar to other faults in the San Andreas shear zone (Mattick and others, 1973) support this assumption. Vertical components of displacement (dip-slip) have also been reported (Woodward-McNeill, 1974a). Faults offset older basin-fill materials along the east (Sheep Mountain fault; Figure 10) and the west (unnamed faults) flanks of the Gila Mountains within the Yuma and Lechuguilla Deserts in LWBGR (Olmsted and others, 1973; Woodward-McNeill, 1974a). Age of faulting has been tentatively dated as less than 200,000 years b.p. with last movement possibly occurring less than 11,000 years b.p., which establishes these faults as capable.

The Chocolate Mountain thrust fault system is present in southern YPG, with exposures in the Laguna, Middle and

Castle Dome Mountains (Figure 7) (Barnett, 1975, in press). This fault apparently pre-dates Basin and Range tectonism (early Mesozoic?) (Davis and others, 1975; Dillon, 1975a, b; Dillon and Haxel, 1975), is not known to have associated Cenozoic displacements or historic seismic activity, and is not considered a capable fault.

2.2.4.2.2 Scarps

A low scarp (less than five feet) is present along portions of a distinct alignment which appears as a lineation on aerial photographs and trends northwestward across San Cristobal Valley in LWBGR (Geology, Y-VII and Y-VIII). This feature was noted during aerial field reconnaissance and aerial photographic analysis; no ground observations were made and the origin of the feature is unknown. Several small magnitude (M=4 to 5) earthquake epicenters are present in this area (Section 2.2.4.4) but their relationship to the lineation is unknown.

Fault scarps in the old basin fill ranging from three to as great as 60 feet (Woodward-McNeill, 1974a) have been reported along the Algodones, Sheep Mountain, and unnamed faults. Confirmation of the exact nature and extent of the scarps was not possible with the brief field reconnaissance, and no aerial photographs were available for analysis.

2.2.4.3 Volcanic Activity

Holocene (Appendix B) volcanic activity has occurred in the

Pinacates Volcanic Field (Figure 9) south of YPG/LWBGR (Merriam, 1972; Ives, 1956) Quaternary (Section 2.2.3.2; Appendix B) volcanic activity has occurred in the Sentinel Flow (Figure 9) and other volcanic fields (Fugro, 1974b) aligned with the Gila Lineament. Eastwood (1974) suggests that, relative to plate tectonics theory, these Quaternary-Tertiary volcanic fields may be associated with East Pacific Rise and the intersections of major structural lineaments. He also suggests a 2.9 percent probability for renewed activity in the next 0.5 million years within the entire Basin and Range Province.

2.2.4.4 Seismicity

Judgement of the level of seismicity of a region is dependent upon the size of earthquakes that have occurred, their frequency of occurrence, and the resulting intensities of ground shaking. Various regions of the United States have relatively high levels of seismicity (e.g., coastal California, Alaska) and others have relatively low levels. The regional seismicity of the western United States is shown in Figure 11.

Prior to 1968, Arizona lacked a well-developed seismic detection network. Therefore, locations of epicenters reported prior to July 1968 are accurate to the nearest 0.1 degree (6 nm) and prior to the middle 1950's probable are accurate to the nearest 1/2 to 1/4 degree (30 to 15 nm) (Hileman, 1973). The detection threshold, or minimum magnitude

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SEISMIC INTENSITIES IN WESTERN UNITED STATES

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FIGURE 11

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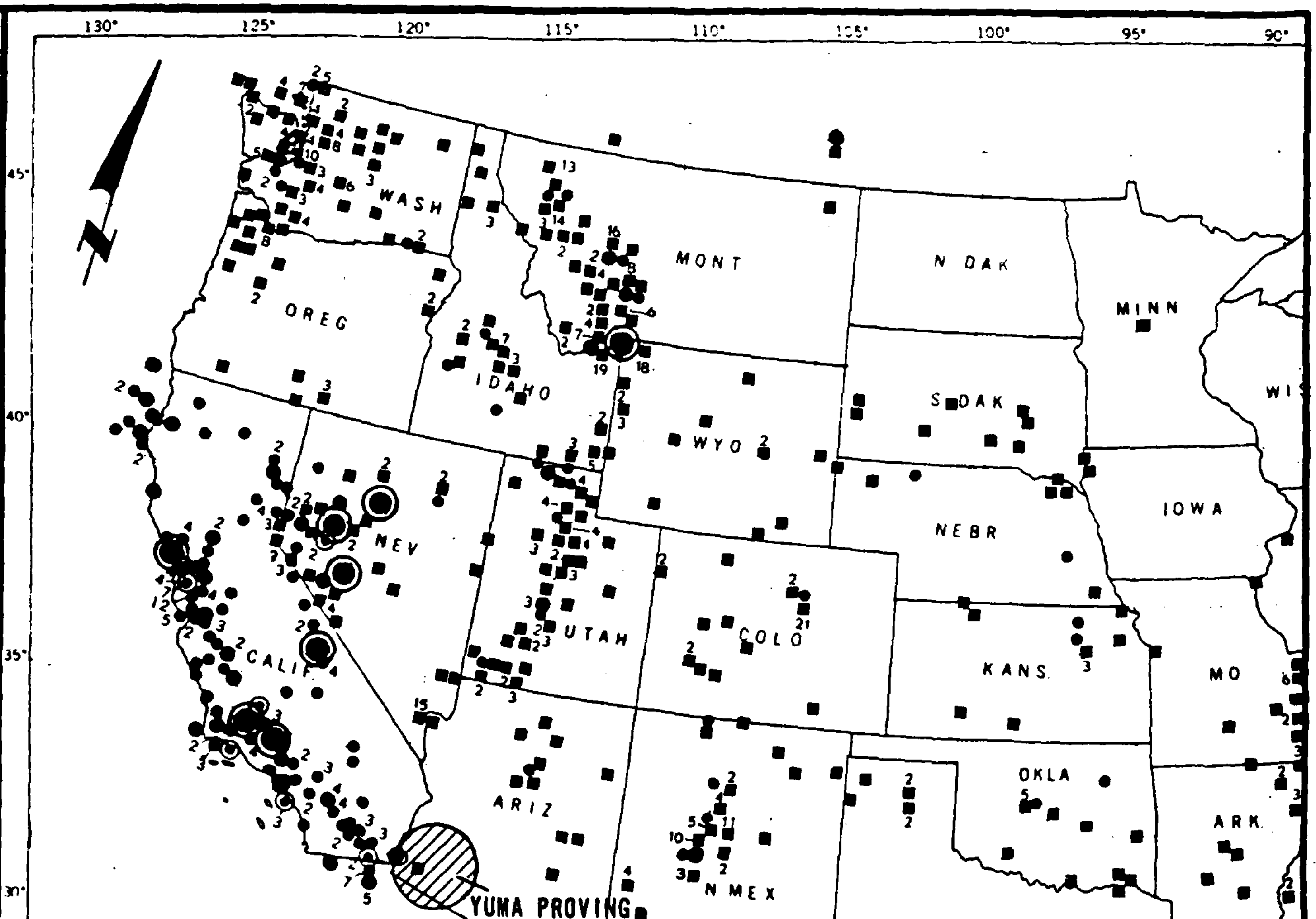
EXPLANATION*

- ■ INTENSITY V-VII (except California)
- • INTENSITY VII-VIII
- ● INTENSITY VIII-IX
- ◎ INTENSITY IX-X
- ⬤ INTENSITY X-XIII

*Earthquakes through 1970 (Modified Mercalli Intensity V and above)



SCALE: 1 INCH = 219 NAUTICAL MILES
1 INCH = 406 KILOMETERS
(APPROXIMATE)

SOURCE:
Coffman and von Hake, 1970. Earthquake History of the United States, Illustration vii.

earthquake recorded, of this system was approximately magnitude 4.5 prior to 1945 and about 4.0 until 1968 (Fugro, 1974a, b). Since 1968, earthquake magnitudes as low as 3.0 have been recorded.

Levels of seismicity of three zones that can affect YPG/ LWBGR are summarized in Table 5. These three zones are: (1) the Salton Trough, including the northwest-trending elements of the San Andreas shear zone and the Algodones fault; (2) a north-northwest trending transition zone extending through central Arizona; and (3) a zone of diffuse seismicity.

The Salton Trough encompasses the Yuma Desert portion of LWBGR. Seismic activity is relatively high in this southeasternmost portion of the San Andreas shear zone with numerous recorded earthquakes of Richter magnitude (M) 6 to 7. The Algodones fault is the closest element of the San Andreas zone, transecting the Yuma Desert in LWBGR.

The second zone of seismicity trends roughly north-northwest across central Arizona and consists of a general concentration of earthquakes ranging from recorded magnitude 4 events to an estimated magnitude 8 event. This seismic zone closely coincides with at least three structural features: (1) the approximate location of the Jerome-Wasatch structural zone, (2) the physiographic boundary

TABLE 5

LEVELS OF SEISMICITY AND SEISMIC RISK IN YPG/LWBGR

Zone and Features Contained Within Zone	Closest Approach to Site (nm)	Magnitude of Earthquakes: Largest Historic (est.)	Magnitude of Earthquakes: Largest Instru-mental	Magnitude of Earthquakes: Maximum Credible	Peak Acceleration Values (in g)(1): Maximum Credible	Peak Acceleration Values (in g)(1): Largest Instru-mental	Recurrence Interval (yrs)/ Magnitude (M)
Zone 1 - Salton Trough							
(a) San Andreas Shear Zone	0	7.75	7.1	8+(2)	0.75+	0.35	10/6; 40/7; 200/8(2)
(b) San Andreas Fault	50	7.75	6.5	8(2)	0.2-0.24	0.1	10/6; 40/7; 200/8(2)
(c) Algodones Fault	0			8+(3)	0.75+		
Zone 2 - Jerome-Wasatch Transitional Zone	60	8	6	7.0-8.0	0.2	0.05	
Zone 3 - Zone of Diffuse Seismicity	0	5	5.0			0.1-0.2(?)	

(1) Peak acceleration values derived from Housner, 1965, and Schnabel and Seed, 1973, using closest approach to siting area.
(2) Lamar and others, 1973
(3) Fugro, 1974

(Transition Zone of Wilson and Moore, 1959) between the Colorado Plateau and the Basin and Range, and (3) a zone of known Quaternary faulting and Cenozoic volcanism. The Sonora, Mexican earthquake (M = 8 est.) of 1887 (Aguilera, 1888) has been related to this zone (Fugro, 1974a), although Sanford and Toppozada (1974) suggest it may have occurred within an extension of the Rio Grande Rift Zone.

The third zone which almost entirely encompasses YPG/LWBGR is characterized by diffuse seismic activity and is bounded by the above-mentioned two zones. Activity consists primarily of sparse, randomly distributed earthquakes of magnitude 4 or less. Available data suggests that these earthquakes cannot be related to any well-defined structural feature. An apparent concentration of earthquake epicenters (M = 4 to 5) in the vicinity of the Pinacates Volcanic Field is apparently due to mislocation. More precise methods of epicentral location in California and Mexico after 1964 have relocated many of these events further south within an area of Quaternary fault activity related to crustal spreading and a possible southeastward extension of the San Andreas shear zone.

Only four instrumentally recorded seismic events have been located within YPG/LWBGR for the period 1927 through 1971 (Figure 10). Located in central LWBGR, two of the earthquakes (M = 4.4 in 1964 and M = 4.7 in 1963) occurred

in Mohawk-Tule Valley, one (M = 5.0 in 1958) in San Cristobal Valley and one (M = 4.1 in 1964) in west-central Growler-Childs Valley. Three recorded seismic events (M = 4.2 in 1950, M = 4.5 in 1951, and M = 4.8 in 1957) are located in Mexico within 5 nm of the southern boundary of LWBGR (Latitude 32.0 N; Longitude 113.0 W). In addition, one event (M less than 5.0 est.) occurred near Wellton in 1935.

The largest recorded earthquakes reported felt in the YPG/LWBGR area occurred on 31 December, 1934 in Baja, California (M = 6.4 to 7.1) approximately 50 nm southwest of YPG/LWBGR and on 18 May, 1940 near El Centro, California (M = 7.1) approximately 40 nm to the west of YPG/LWBGR.

Little is known about the pre-instrumental (pre-1927) earthquake history of the southwest, including YPG/LWBGR, because of sparse settlement and a lack of records of earthquake effects. Historic records were first kept at Fort Yuma, Arizona in 1852, since it was the only potential reporting station in the immediate area. Table 6 lists pre-1927 earthquakes reported in the vicinity of YPG/LWBGR. The Modified Mercalli Intensities (MMI; Appendix D) are the strongest reported, and occurred at the locality listed. Richter magnitudes and distances from YPG/ LWBGR are estimated. The largest historic earthquake (M = 8 est.) felt in the YPG/LWBGR area occurred on 3 May, 1887 near Sonora, Mexico.

TABLE 6

List of Pre-1927 Earthquakes in the Vicinity of YPG/LWBGR

Year	Date	Locality of MMI	Magnitude/ Max. Est. Intensity (MM)	Approximate Distance of Locality from YPG/LWBGR
1852	9 Nov.	Imperial Valley SW of Fort Yuma, Arizona	?/VIII - IX	6 nm (?)
1853	Dec.	Fort Yuma, Arizona	?/X-XI(?)	6 nm (?)
1857	8 or 9 Jan.	Fort Yuma, Arizona	8+ est./IX(?)	130 nm (?)
1871	August	Imperial Valley, California	?/IX or X	40 nm
1887	3 May	Sonora, Mexico	8 est./?	150 nm
1915	22 June	Imperial Valley 32.8N, 115.5W	7-7.5 est./IX	6 nm
1915	20 Nov.	Imperial Valley, California	?/VI	40 nm

Sources: Coffman and von Hake, 1973; Sturgul and Irwin, 1971; Bonilla, 1967; Townley and Allen, 1939.

2.2.4.5 Seismic Risk

The probability of the occurrence of potentially damaging earthquakes is of major concern in evaluating the seismic risk of a region. The factors that influence the determination of seismic risk are: (1) the size and location of capable faults; (2) the level of seismicity of the region, in particular the seismicity associated with capable faults; and (3) levels and intensities of earthquake induced

vibratory ground motion caused by earthquakes in regions of concern.

Studies predicting the susceptibility of an area to relative levels of seismic intensity have been done for the western United States, and show that nearly all of YPG/LWBGR has a maximum expected seismic intensity (measured on the MMI scale) of V to VI (Algermissen, 1969), with a maximum expected seismic intensity of VII to IX within the Yuma Desert portion of YPG/LWBGR contained within the Salton Trough (Richter, 1959). One event occurred in 1935 near Wellton, producing a maximum MMI of VI and only local effects. Table 5 (Section 2.2.4.4) summarizes the seismic risk associated with the three zones of seismicity defined for YPG/LWBGR.

2.2.4.5.1 Levels of Vibratory Ground Motion

Maximum credible earthquakes are the largest earthquakes that faults or fault zones are thought capable of producing. These earthquakes generate maximum levels of vibratory ground motion (Table 5). The maximum credible shaking that can occur is at the level that has been observed very near to the fault break during major earthquakes. Examples of this very severe level of vibratory ground motion are those experienced in San Francisco in 1906 (M = 8.3?), in the Fort Tejon area in 1857 (M = 8+) and in the Lone Pine area during the 1872 Owens Valley earthquake (M = 8+). However,

because of the lack of accelerograms obtained very near the fault break, only estimates of the quantitative level of ground motion can be made. The estimates of different investigators show wide discrepancies; it has been estimated that peaks of acceleration ranging from one-half to more than one g (g being the acceleration due to gravity) can be expected.

Maximum credible earthquakes can be estimated for the Salton Trough and Transition Zone (Table 5). The greatest potential seismic risk would result from an earthquake associated with the Salton Trough, along the San Andreas zone, specifically the Algodones fault. The San Andreas zone is capable of an $M = 8+$ (*Sturgul and Irwin*, 1971; Hileman, 1973). Should such an event occur within the southern portion of the San Andreas zone very close to or within YPG/LWBGR, peak accelerations ranging from 0.5g to more than 1.0g can be expected in the vicinity, very near or directly above the fault break (Housner, 1965; Donovan, 1973).

Attenuation of the vibratory ground motion with increasing distance from such an event ($M = 8$) would result in decreasing maximum accelerations (e.g., 0.4g at 15 nm, 0.3g at 30 nm, 0.12g at 60 nm; derived from Schnabel and Seed, 1973). The following recurrence intervals (RI) have been determined for events less than the maximum credible

within the southern segment of the San Andreas shear zone: for M = 6, RI = 10 years; for M = 7, RI = 40 years; and for M = 8, RI = 200 years (Lamar and others, 1973). Effects of these recurring events on YPG/LWBGR will, of course, depend upon the distance of the event from the siting area and the nature of local geologic, groundwater and soil conditions.

Algermissen (1969) suggests the maximum credible earthquake within the Transition Zone (the Jerome-Wasatch Structural zone) would have a magnitude of 7.0 to 8.0, with the maximum probable earthquake (the largest earthquake likely to occur within about 100 years) of M = 5.5 in the vicinity of the closest approach to the complex (Hileman, 1973). Based on Housner (1965) and Schnabel and Seed (1973), and closest approach of 60 nm, an event of M = 8.0 would generate levels of vibratory ground motion of less than 0.2g, and an event of M = 5.5 at this distance would generate ground shaking levels of less than 0.05g.

The capability for generating high levels of vibratory ground motion within YPG/LWBGR also exists within the zone of diffuse seismicity if earthquakes of M = 4.0 to 5.0 occur within YPG/LWBGR. Four such events have been recorded in LWBGR. Vibratory ground motion levels of 0.1g for M = 4 and 0.2g for M = 5 could be expected from such events as predicted by Donovan (1973). However, recent

accelerograms recorded near surface ruptures associated with small magnitude events (M less than 5), such as the Bear Valley earthquake of September 1972 (M = 4.9), indicate that accelerations can be as large as approximately 0.7g (determined by Earthquake Engineering Research Laboratory, California Institute of Technology). The duration of strong ground motion from such small magnitude earthquakes would be only about five seconds.

2.2.4.5.2 Teleseismic Events

Distant earthquakes (generally exceeding 100 nm) of M = 5 to 7 and large magnitude (M = 8+) teleseismic events (distances greater than 540 nm; Richter, 1958) may affect the siting area. Of primary concern are the long period waves generated by these distant earthquakes. Resonance may produce oscillation of pools of water (seiches) or damage long period structures. The most likely sources for distant large magnitude earthquakes in the seismically active portions of the western United States (Figure 11) are: 1) portions of the San Andreas system lying greater than 100 nm to the northwest, 2) the Agua Blanca fault lying approximately 150 nm to the southwest, 3) the Rio Grande Rift Zone (Figure 10) lying 250 nm east of the complex, and 4) an area of seismicity 250 to 275 nm to the north-northwest in north-central Nevada (near Reno). In addition, teleseismic events of large magnitude may be associated with the Aleutian and mid-America

trenches.

2.2.4.5.3 Potential for Surface Displacement

The greatest potential for surface displacement due to faulting lies in the Yuma and Lechuguilla Deserts. The existence of fault scarps with significant offsets associated with the Algodones, Sheep Mountain and other unnamed faults, substantiate this potential. Based on Bonilla (1967) vertical displacements of 3 to 15 feet could occur on these faults, associated with an earthquake event of M = 8+.

2.2.4.6 Tectonic Subsidence

Subsidence within YPG/ LWBGR due to tectonism has not been reported. Postulated subsidence occurrences and mechanisms are discussed in Section 2.4.2.7.

2.3 SOILS ENGINEERING

2.3.1 GENERAL

The soils engineering data and design evaluation information presented here are derived primarily from Soil Conservation Service (SCS) reports (Hartman, 1973; Richardson, 1973; Chamberlain, 1974). These reports delineate various soil and rock units as generalized soil types on small-scale maps. For this reason, the SCS map units were adjusted and refined to conform to the geologic units (Geologic Overlays) derived by aerial photographic interpretation and limited field observations, and are presented on the Soils Engineering overlays (Y-I through Y-IV, Y-VI through Y-X, Y-XII through Y-XV). Specific engineering information on soil properties from borings or test pits within YPG/LWBGR is sparse (Appendix F), but where available, the information was incorporated into the description of the related map units and onto the Soils Engineering Data Summary Sheets.

The Soil Conservation Service basically describes soils in agricultural terms and may incorporate more than one soil type defined by the Unified Soil Classification System (USCS; Appendix E). The soil classification assigned to a map unit (Soils Engineering overlays) represents the predominant soil type, but not necessarily the only soil type within that particular map unit.

Soils Engineering Data Summary Sheets (Section 3.0) present both specific engineering data where available in the

literature and engineering design evaluations using the available data together with engineering judgement. Design information should be considered general rather than specific for any map unit and used for concept consideration, but not for specific design.

Data from borings or test pits are presented in Appendix F. The limited amount of subsurface data did not allow for extrapolation of soil properties below the surficial five feet. There is a significant quantity of soils engineering data available on the Yuma Test Station Headquarters area (U. S. Army Corps of Engineers, 1952a, 1952b, 1953a, 1953b, 1957a, 1957b, 1960, 1963, 1966, 1968, 1971a, 1973a, 1973b, 1974). However, this area is excluded and data could not be extrapolated into the siting valleys with any accuracy.

YPG/LWBGR can be considered, for a regional engineering discussion, to consist primarily of coarse-grained basin-fill deposits (including alluvial fan, bajada, pediment, terrace, floodplain, stream channel and undifferentiated deposits) which extend basinward from the mountains. Fine-grained basin-fill deposits (playas) exist adjacent to the alluvial fans and are of limited areal extent comprising less than one percent of YPG/LWBGR (Section 2.2.2.4). Wind-blown sands are also present but comprise less than one percent of the siting valley area (Section 2.2.2.5).

All major soil types defined by the Unified Soil Classification System are present in YPG/LWBGR. Coarse-grained basin-fill

deposits generally consist of gravel-, sand- and silt-size material deposited by relatively high energy surface water flow. Fine-grained basin-fill deposits consist of clay and silt-size material laid down in a low energy environment. The wind-blown sands consist of a uniform medium to fine sand.

2.3.1.1 Coarse-Grained Basin Fill

The coarse-grained basin fill encompasses 98 percent of the siting valley area and is the major soil types within YPG/ LWBGR. Of this total, 91 percent is alluvial fan and undifferentiated deposits, seven percent stream channel and flood plain deposits and two percent pediments. The average grain-size distribution of the coarse-grained basin fill is 30 percent gravel, cobbles and boulders, 40 percent sand, 25 percent silt, and five percent clay. These percentages will vary depending upon nearness to the mountains and/or stream channels, relative age of the geomorphic surface, process by which the material was deposited, and the parent material.

The coarse-grained basin-fill areas are generally considered the most suitable for siting because of the granular nature of the soils and the absence of near-surface groundwater and surface water. The portions of these areas which contain possible design problems are the pediments where rock is encountered within ten feet of the ground surface, areas where caliche is present, and stream channels and floodplains where a high flooding potential exists.

2.3.1.2 Wind-Blown Sand

Wind-blown, uniformly sized sands are loose and dry, and as such present some design problems. Construction problems in these areas include low strength values, erosion and higher maintenance costs related to certain MX design concepts.

2.3.1.3 Fine-Grained Basin Fill

Playas consist of heterogeneous mixtures of clay, silt and sand with the clay- and silt-size material (finer than the #200 sieve) totaling 90 percent. While these soils have a well-defined surface extent, they may have a greater (presently unknown) areal extent with increasing depth (Section 2.2.2.4). The fine-grained basin-fill soils are generally considered to have more extensive design problems than the coarse-grained basin fill due to their strength dependence upon moisture content. Flooding in these areas is also a potential problem.

The fine-grained basin fill and wind-blown sand areas account for a small percent (less than two) of the YPG/LWBGR siting valley area. For this reason, these materials do not warrant extensive discussion. Special design considerations may be required for roads, excavations and foundations in these areas.

2.3.2 ROAD CONSTRUCTION

Specific design data for road construction, including California Bearing Ratio values (CBR; American Society for Testing and Materials, Designation D 1883), AASHO classifications (Appendix B), and shrink-swell potential, are presented in the Data Summary Sheets where available. Since little or no specific

data are available for actual design values, the following discussion provides some general information on road design in YPG/LWBGR based on available soil data and engineering judgement. Trafficability of unimproved terrain is considered in the Terrain Analysis (Section 2.6).

For most of the YPG/LWBGR siting valley area it is estimated that a CBR value of 10 to 20 is reasonable for in-situ material and a CBR value of greater than 20 and on the order of 30 to 40 can be obtained by scarifying and recompacting the surface soils. Lower CBR values (less than 20) will be obtained in the playa areas.

Flash flooding (Section 2.4 and Section 2.5) may occur in gullies and intermittent drainages, requiring either periodic road repairs or design of costly road structures across these areas. Maintenance to clear debris deposited by runoff (2.4.1.5) should also be anticipated. Paved roads with reinforced concrete aprons have been placed on the channel invert but still require maintenance and in some areas have been completely washed out by flash floods.

Wind erosion and shifting sand in the dune areas will necessitate periodic road maintenance or some form of surface stabilization of adjacent dunes. Wind erosion and shifting soil occurs to a lesser extent (i.e., limited amount of movement, fine material only) throughout YPG/LWBGR, but is not considered a significant design problem.

2.3.3 EXCAVATIONS

No test data are available upon which to base design evaluations for excavations. Considerations for making excavations involve the following factors:

1. stability of excavation side slopes,
2. presence of free groundwater,
3. presence of caliche,
4. presence of unrippable rock (Section 2.2.3), and
5. presence of cobble- and boulder-size material.

Based upon the engineering and geologic classifications of the surficial soils and engineering judgement, the ease of excavation for each soil map unit has been evaluated and is presented in the Data Summary Sheets. The following discussion provides some general information on excavations in YPG/LWBGR.

Most soils in the coarse-grained basin-fill areas can be excavated with conventional equipment at a slope angle of 45 to 60 degrees with the horizontal. In the sheet sand areas, flatter side slopes will be required. Caliche and cobbles or boulders may be widespread and occur randomly throughout the older alluvial fan areas and where known to be present (Section 2.2.2.2), it has been noted on the Data Summary Sheets. Blasting of caliche has been required in similar coarse-grained alluvial fan areas north of the siting area.

Near-surface rock (less than 25 feet) may occur along the mountain flanks. Depth to rock in pediment areas is less than

ten feet. Map units with near-surface rock are indicated on the Data Summary Sheets. In addition, subsurface volcanic flows may be encountered. With the exception of a few seismic velocity measurements, no information was available on which to base an evaluation of the methods needed to excavate near-surface rock.

The static groundwater table is generally greater than 100 feet below the ground surface in YPG/LWBGR (Section 2.4.2.3) and should not create dewatering problems in excavations. However, perched water is known to occur in portions of YPG/LWBGR (Section 2.4.2.4). It is not known to what extent perched water may be encountered in excavations.

2.3.4 FOUNDATIONS AND STRUCTURAL CONSIDERATIONS

2.3.4.1 General

Depending upon the MX Siting concept selected, foundation design may or may not be required. If required, important factors to be considered in foundation design include:

1. bearing capacities,
2. settlement and swell potential, and
3. the corrosivity of the soil.

No specific test data are available on which to base recommendations for foundation design, but each map unit is evaluated qualitatively using engineering judgement for relative foundation analysis. The model considered for foundation evaluation was a partially buried reinforced concrete structure with a level floor slab at approximately 24 feet below

the existing ground surface (TRW Systems Group, 1975). Although the soil descriptions and properties presented in the Data Summary Sheets are only considered to be applicable to a depth of five feet, the soil properties for the foundation analysis were assumed to extend to the depth of influence of the foundation. The relative shear strength, compressibility and expansiveness of each unit were considered and are presented in the Data Summary Sheets.

The soils within the YPG/LWBGR siting valley area are generally satisfactory for the support of near-surface foundations, with moderate bearing values on the order of 2 to 6 kips per square foot considered feasible. Exceptions to this are the playa areas which will support lower values (1 to 3 kips per square foot). The shrink-swell potential of the soils throughout the area is generally low (except for playa deposits), and provisions in design to account for this condition should be minimal or only required locally. The alluvial fans are considered to have a moderate compressibility and settlements should be within normal design tolerances. An exception to this may be in areas of recent alluvium which are porous and potentially collapsible when saturated. The collapsible soil condition has been documented in several arid region studies, however, collapsible soil areas could not be differentiated within YPG/LWBGR based on available information. Greater differential settlement is likely to occur in the playa areas where soil strengths are considered weaker.

2.3.4.2 Other Considerations

Other structural design considerations such as lateral pressures on walls and footings, slab support, liquefaction, and soil-structure interaction during ground shaking due to earthquakes or blast forces have not been presented. Although some gross estimates could be made regarding these design criteria, the information available in the literature is too sparse for this detailed type of analysis.

2.3.5 SOURCES OF CONSTRUCTION MATERIAL AND SOIL STABILIZATION

2.3.5.1 General

Potential uses of construction material include:

1. sand and fill material,
2. aggregate for base coarse and concrete,
3. material for rip rap, and
4. material for low permeability pond liners.

Potential uses of the material are listed on the Data Summary Sheets. Available data were used in evaluating each of the map unit soil types for use as a construction or stabilization material.

2.3.5.2 Sand and Fill Material

The suitability of each soil map unit as a source of sand and/or fill material was evaluated, with nonexpansive coarse-grained material containing few fines considered desirable. In general, the coarse-grained alluvial fans, stream channels and the limited sand dune areas will provide the best sources of sand and fill material. Some materials possess desirable

properties for concrete sand and/or fill, but are given a poor rating in the Data Summary Sheets because of a limited quantity of easily obtainable material. Near-surface rock and near-surface groundwater are considered undesirable properties when identifying easily obtainable sand and fill material.

2.3.5.3 Aggregate for Base Course, Concrete and Rip Rap

Well graded gravels with some sand, and little or no fines and cobbles, are considered the most desirable material for concrete aggregate and/or road base course. Stream and wash channels are good sources of aggregate. Depending upon the intended use of the material, rock may be blasted and crushed to obtain a specific size aggregate or rip rap; however, the economic considerations of blasting and crushing must be considered. Potential rock and aggregate quarries may be present within the mountain areas. Caliche has been blasted and crushed to obtain road base course (New Mexico State Highway Department, 1972). The quantity, quality and geographic distribution of caliche is not well known (Section 2.2.2.1). Undesirable conditions for excavating sources of aggregate include near-surface unrippable rock and groundwater, both of which limit the amount of easily obtainable material. In addition, those soil units with sulfates (deleterious to concrete) and/or high alkalinity (corrosive to uncoated steel) are noted on the Data Summary Sheets.

2.3.5.4 Material for Impermeable Liners

Desirable soil properties for use as an impermeable liner are a low permeability and adequate shear strength to remain stable when saturated. The permeabilities reported in the literature vary for clayey soils by a factor of 100 due to a wide variation in soil types. This factor could be significant when evaluating seepage losses from a pool. Testing will be required to adequately evaluate the material permeability when recompacted. Generally, the playas are considered good sources of low permeability material. However, they account for only one percent of the siting valley area in YPG/LWBGR and may not provide a sufficient amount of native material for the pool siting concept.

2.3.5.5 Soil Stabilization

Stabilization of the various soils by the additions of cement and chemicals is possible. In general, cement can be mixed with all soils to create a stabilized soil-cement, road base or surface, although clay soils are more difficult to mix and require higher percentages of cement.

Asphalt can also be combined with granular materials to create a stabilized asphaltic concrete. Polymer compounds are available as a cementing agent for granular materials, but are generally quite costly.

Chemical stabilization with cement or lime can be used to reduce the shrink-swell potential of clays in the playa areas.

Cement, lime and long-chain polymer chemicals can also be used to reduce the permeability of soils when mixed and recompacted. Testing of the reactions between the particular additive and the specific soil to be stabilized will be necessary for proper design.

2.4 HYDROLOGY

2.4.1 SURFACE HYDROLOGY

2.4.1.1 General Surface Hydrologic Conditions

Approximately 90 percent (3888 nm^2) of YPG/LWBGR is located within the Lower Main Stem Subregion and the remaining ten percent (432 nm^2) lies within the Gila Subregion of the Lower Colorado Hydrologic Basin (Lower Colorado Region State - Federal Interagency, 1971).

Unlike most of the Basin and Range Province where surface drainage is typically a closed-basin system draining into playas, the surface drainage within YPG/LWBGR is through-flowing to the Gila or Colorado Rivers with only very limited closed-basin drainage (Table 7, Section 2.4.1.3).

2.4.1.2 Perennial Systems

Perennial systems refer to lakes, rivers, and streams which contain water throughout the year. There are no known perennial systems within YPG/LWBGR. The Colorado River, located less than 0.5 nm west of YPG at its closest approach, and the Gila River, which separates YPG and LWBGR, are the only perennial drainages adjacent to the siting area (Figure 4).

The only spring known to exist within YPG/LWBGR is Agua Dulce Spring in southeastern Mohawk-Tule Valley (Hydrology, Y-XIV). The slow rate of seepage of this spring provides water for wildlife in a man-made tank in the Cabeza Prieta Game Range (U. S. Bureau of Sport Fisheries and Wildlife, 1965b).

2.4.1.3 Ephemeral Systems

Ephemeral systems include playas, drainages (streams and washes) and natural reservoirs. Within YPG/LWBGR playas are confined primarily to small (less than one nm^2), topographically low, indrained areas peripheral to the alluvial fans in Mohawk-Tule and Growler-Childs Valleys in LWBGR. The length of time water is retained in the playas depends generally upon rainstorm duration and intensity, and the runoff characteristics of the watershed. Playas present in southern Mohawk-Tule Valley include Las Playas, Dos Playas, and Pinta Playa (Hydrology, Y-XIII and Y-XIV).

Primary ephermeral drainages are those large drainages commonly found in the central portion of a Valley, or which drain very large watershed areas near the mountains. Table 7 lists the primary ephemeral drainages, their respective Valleys, and pertinent four-quad areas. They commonly supply intermittent seasonal (generally summer and fall) water flow in the area.

Generally smaller in size but greater in number are the secondary ephemeral streams which drain smaller drainage basins and are the major tributaries to the primary drainages. Numerous secondary drainages occur throughout YPG/LWBGR providing periodic flow during and immediately following intense or long duration rainstorms. Water use restrictions due to possible non-DoD ownership of primary and secondary ephemeral stream water rights are not foreseen in YPG/LWBGR.

Natural reservoirs are naturally occurring depressions that

TABLE 7

YPG/LWBGR Surface Drainage Systems

Valley	Primary Ephemeral Drainages	Principal Drainage Basin	Playas	Applicable Four-Quad
La Posa Plain	Tyson Wash	Colorado River		Y-I, Y-III
Mohave Wash Valley	Ehrenberg Wash Gould Wash Mohave Wash Mule Wash Pete's Wash Trigo Wash Weaver Wash	Colorado River		Y-I, Y-II, Y-III
Indian Wash Valley	Indian Wash Los Angeles Wash McAllister Wash Yuma Wash	Colorado and Gila Rivers		Y-II, Y-III, Y-VI
Castle Dome Plain	Big Eye Wash Castle Dome Wash	Gila River		Y-II, Y-VI-Y-III
King Valley	-	Gila River		Y-IV, Y-VII
Palomas Plain	Hoodoo Wash	Gila River		Y-IV
Yuma Desert	-	Colorado and Gila Rivers		Y-VI, Y-XII
Lechuguilla Desert	Coyote Wash	Gila River		Y-VI, Y-XII, Y-XIII
Mohawk-Tule Valley	Mohawk Wash	Gila River	3	Y-VII, Y-XIII
San Cristobal Valley	San Cristobal Wash	Gila River		Y-VII, Y-VIII, Y-XIV
Growler-Childs Valley	Daniels Wash Growler Wash San Cristobal Wash Ten-Mile Wash	Gila River	1	Y-VIII, Y-XIV, Y-XV
Sentinel Plain	Midway Wash Ten-Mile Wash	Gila River		Y-VIII, Y-IX
Gila Bend Plain	Quilotosa Wash Sauceda Wash	Gila River		Y-IX, Y-X
Vekol Valley	Bender Wash	Gila River		Y-X

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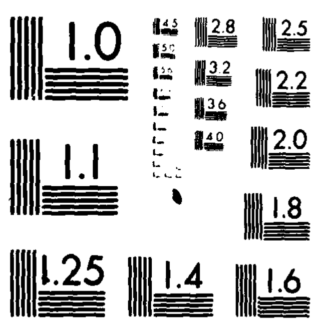

MICROCOPY RESOLUTION TEST CHART
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collect and store water (Bryan, 1920). These natural reservoirs include rock tanks (depressions formed in rock), charcos (depressions formed in fine-grained material), and sand tanks (sand-filled rock tanks). Water may be supplied by direct precipitation and runoff or by springs. The length of time that water remains in these features depends on local conditions (i.e., permeability, source of water; Bryan, 1925a). Rock tanks are present in the Tinajas Atlas, Sand Tank, Tule, Crater and Aguila Mountains and Baker Peaks; charcos are present in Vekol Valley and the Crater Mountains area; sand tanks are present in the Sand Tank and Crater Mountains (Bryan, 1922b, 1925; Ross, 1922, 1923).

2.4.1.4 Surface Water Quality

Surface water in these ephemeral systems varies from fresh to moderately saline (Table 8). Total dissolved solids (TDS) are generally much greater than 500 milligrams per liter (mg/l) with the principal constituents being chlorides, sodium and bicarbonate (Lower Colorado River State - Federal Interagency Group, 1971). Stulik and Moosburner (1969) report a maximum of 7400 mg/l TDS ranging in the Gila Bend Plain with weighted annual averages from 2890 mg/l in 1964 to 6130 mg/l in 1952, making the water slightly to moderately saline. The major contaminants of the surface waters include boron, nitrates and fluoride, with the latter averaging from three to four mg/l (Lower Colorado River State-Federal Interagency Group, 1971).

TABLE 8

Classification of Fresh and Saline Water

Water Type	Total Dissolved Solids (mg/l)
Fresh (F)	< 1000
Saline	> 1000
Slightly saline (SS)	1000 to 3000
Moderately saline (MS)	3000 to 10,000
Very saline (VS)	10,000 to 35,000
Brine (B)	> 35,000

Source: Robinove, Langford and Brookhart, 1958

2.4.1.5 Runoff Characteristics

Direct runoff is defined as water received at the surface in excess of the retention (amount of water necessary for soil saturation) loss rate (U. S. Bureau of Reclamation, 1973). Accurate calculations of the amount of direct runoff which can occur in YPG/LWBGR are difficult because of the sparseness of accurate stream gaging data within the siting area. Some estimates can be made by studying and classifying the general soil characteristics of the basin and watershed geology and the physical characteristics of the streams in the area, and by reviewing runoff studies conducted in similar environments. Estimates for direct runoff in YPG/LWBGR are based upon: 1) analysis of surface runoff in the western portion of YPG/LWBGR (Hely and Peck, 1964), 2) analysis of existing records adjacent to the area (U. S. Geological Survey, 1964, 1965b, 1967,

1968b, 1969, 1974a; Aldridge, 1970), 3) studies done in similar desert environments (Davis, 1938; Lowdermilk, 1952; Benson, 1964; Croft, 1967; Moore, 1968; Rahn, 1968; Baker, 1973), and 4) general runoff calculations performed by the U. S. Bureau of Reclamation (1973).

These studies indicate that in the western half of YPG/LWBGR direct runoff ranges from less than 0.02 inches to greater than 0.5 inches (less than one percent to approximately ten percent of the mean annual precipitation) in the valley areas, with the larger values generally corresponding to topographically higher portions of the valley. Greater runoff values ranging from 0.5 inches to greater than 2.5 inches (approximately 15 percent to greater than 30 percent of the mean annual precipitation) occur in the mountainous areas of greater than ten percent grade where annual rainfall amounts range from six to greater than ten inches and infiltration is low due to the essentially impervious nature of the rock units exposed at the surface.

Basin areas with nearly impervious soils (playas and pediments) may have higher runoff values (Rahn, 1968) than re[illegible]d by Hely and Peck (1964) for the general valley areas due to a low infiltration rate.

Runoff studies are lacking in the eastern portion of LWBGR. However, greater runoff values can be expected in this portion of YPG/LWBGR since it receives a greater annual precipitation (Section 2.5.1.1) and has extensive areas of pediment (Section

2.2.2.3). Based on these factors, direct runoff is estimated to range from 0.5 inches to greater than 1.8 inches (approximately nine percent to greater than 30 percent of the mean annual precipitation) in the valley areas, with the larger values generally corresponding to topographically higher portions of the valley. Greater runoff values can be expected in the pediment areas which have a very thin mantle of pediment deposits and in the mountainous areas of greater than ten percent grade due to low infiltration rates.

2.4.1.6 Debris Flows

Debris flows are high density (large proportion of sediment load) and high viscosity (compared to stream flow) masses that generally are confined to stream channels with limited overland flow. Typically, debris flows occur following high intensity rainfalls in areas of high surface runoffs; they are of short duration (one hour or less) and may consist of either single or multiple pulses (Croft, 1967). The sediment load may be derived from soil erosion or channel degradation, or both, with the average grain size of the sediment load varying from fine-grained (mudflows) to medium-grained (mud-rock flows) to coarse-grained (rock flows) depending on the source area and stream gradient.

High intensity rainfalls (i.e., thunderstorms; Section 2.5.1.1), direct runoff rates (Section 2.4.1.5) and abundant sediment sources within YPG/LWBGR suggest a potential for debris flows. However, there is no known geologic evidence suggesting the

occurrence of debris flows within YPG/LWBGR in historic time (H. F. Barnett, oral communication, 1975).

2.4.1.7 Design Flood Determinations

The maximum probable rainfall an area may receive is used to determine design floods. Information in this section presents maximum point rainfall values based on studies of probable maximum general-type storms. YPG/LWBGR lies approximately 375 to 485 nm west of the 105° meridian which is the dividing line between rainfall presented as probable maximum general-type storms and probable maximum precipitation (PMP) (U. S. Bureau of Reclamation, 1973). Because PMP information is only available for areas east of the 105° meridian and there is a lack of detailed existing data for computation of such values within YPG/LWBGR, PMP values are not presented here.

The probable maximum six-hour point rainfall values for a general-type storm are based upon approximately 330 design storm analyses prepared by the Bureau of Reclamation and numerous other design storm analyses by the National Weather Service (U. S. Bureau of Reclamation, 1973). These values can be applied to areas up to 1000 square miles (754 nm^2). The probable maximum six-hour point rainfall values for YPG and LWBGR (west of 114° meridian) and for LWBGR (east of 114° meridian) are shown in Table 9. Also included are values for storm durations of increments less than and greater than six hours.

TABLE 9

Ranges of Probable Maximum Point Rainfall Values

Duration (Hours)	Probable Maximum Point Rainfall Values General-Type Storm (in inches)	
	YPG and LWBGR (West of 114° Meridian)	LWBGR (East of 114° Meridian)
1	1.8	2.1
2	2.9	3.4
4	4.7	5.5
6	6.0	7.0
12	9.2	10.7
18	11.2	13.1
24	12.6	14.7
48	14.5	16.9

Duration (Hours)	Probable Maximum Point Rainfall Values for Thunderstorms (in inches)
	YPG/LWBGR
0.25	5.3
0.50	7.8
1	11.0
2	13.9
3	14.7

Source: U. S. Bureau of Reclamation, 1973

As mentioned in Section 2.5, thunderstorms account for the most intense rainfall that occurs in YPG/LWBGR over a short period of time. The rainfall values for the probable maximum thunderstorm for YPG/LWBGR are also shown in Table 9 for areas as large as 100 square miles (75 nm^2) and increments of time less than and greater than one hour. For design purposes, the probable maximum thunderstorm rainfall should be assumed to occur over the upstream area nearest the point of interest for those drainage basins exceeding 100 square miles in the area.

The variable topography in the southwestern portions of the United States greatly influences the flooding potential and permits only limited transposition of storms. The point values presented in Table 9 can be applied to areas up to 1000 square miles for general-type storms and 100 square miles for thunderstorms by multiplying the point values by the appropriate ratio shown in Table 10.

2.4.1.8 Flooding Potential

Qualitative flood susceptibility ratings of unknown, high and extreme have been assigned to the major drainages and landform surfaces within the siting area based upon the parameters shown in Tables 11 and 12. Susceptibility to flooding is dependent upon rainfall intensity and duration, and the size and the runoff characteristics of the contributing drainage basins. Analysis of those parameters can only be done when more detailed data are available. The appropriate flood susceptibility

TABLE 10

Conversion of Point Rainfall Values to Area Values

General-Type Storm		Thunderstorm	
Area (sq. miles)	Ratio	Area (sq. miles)	Ratio
100	0.90	10	0.80
200	0.82	20	0.72
400	0.71	40	0.63
600	0.68	60	0.57
800	0.66	80	0.52
1000	0.65	100	0.47

Note: Multiply the above values by the appropriate point rainfall values for area conversion.

Source: U. S. Bureau of Reclamation, 1973

TABLE 11

Flood Potential Susceptibility Parameters for Drainage Channels or Systems

Flood Susceptibility Rating (Overlay Symbol)	Description
Extreme (CF2)	Documented historic flooding and damage or significant geologic/geomorphic evidence (e.g., channel morphology, depth of incision, over-bank deposits) suggests periodic torrential water flow. Predominantly primary drainages.
High (CF1)	Possible evidence of historic flooding and specific geologic/geomorphic evidence suggests periodic torrential water flow. Predominantly secondary drainages.
Unknown (no symbol)	No specific evidence to indicate flooding potential, and/or drainages in areas not analyzed. Predominantly minor secondary or smaller drainages

TABLE 12

Flood Potential Susceptibility Parameters for Landform Surfaces

Flood Susceptibility Rating (Overlay Symbol)	Description
Extreme (SF2)	Historic or significant geologic/geomorphic evidence of ponded flood waters.
High (SF1)	Historic or geologic evidence of significant overland flow or sheet flooding. Possible historic or geologic/geomorphic evidence of ponded flood waters, overland flow or sheet flooding.
Unknown (no symbol)	No sufficient evidence to indicate flooding potential.

symbol (e.g., CF2) designations appear on the Surface Hydrology Overlays except for Y-V and Y-XI.

In general, the CF1 and CF2 drainages correspond to primary and major secondary drainages which have reported occurrences of flood water. In addition, evidence was gathered from a brief field reconnaissance and discussions with personnel at YPG and Luke AFB who report periodic flash flooding and repair of roads. Evidence for periodic flooding was noted:

1. Along U. S. 95 from Yuma to Quartzsite traversing YPG where reinforced concrete aprons have been placed across the highway to accomodate flood waters;
2. Along U. S. 85 from Gila Bend to Ajo traversing LWBGR, which showed effects of gullying, previous washouts, and repairs of the road surface; and
3. Several washouts in improved dirt and paved roads in the southern portion of YPG.

The above-cited instances are not considered to be all of the areas susceptible to flooding, rather these are the areas which were noted in a brief field reconnaissance and aerial photographic analysis, or which had historic and/or geologic evidence for flooding.

Landforms were rated based on their susceptibility to flooding, however, most areas lacked sufficient evidence to indicate flooding potential. A flood susceptibility rating can be applied in association with a landform without specific boundaries, but it will only apply locally.

In general, the topographically higher, more deeply incised, pediments and fan surfaces exhibit a low to moderate flood hazard since most runoff would be channelized (Rahn, 1968). Portions of younger coalescing alluvial fans (bajadas) may have a moderate to high susceptibility to flooding because of possible overbank flooding of the numerous smaller drainages and sheet flow (Rahn, 1968). Sheet flow predominates over channel flow in La Posa Plain and King Valley in YPG.

The generally deep groundwater table throughout the area suggests that the playas present in LWBGR lose water through evaporation and infiltration of surface water derived from runoff or direct precipitation. Playas in LWBGR may have high flood hazard due to the presence of ponded surface water during or immediately following intense rainstorms.

2.4.2 GROUNDWATER HYDROLOGY

2.4.2.1 General Groundwater Conditions

YPG/LWBGR encompasses portions of two major groundwater regions. In the larger of these two areas, groundwater flow is generally toward the Gila River Valley and includes most of the northwest-trending valleys. In the smaller area, which includes the western portion of YPG and the Yuma Desert in LWBGR, groundwater flow is toward the Colorado River Valley. In both regions, groundwater is known to occur in basin-fill, perched and rock aquifers.

Groundwater level fluctuations cannot be determined for the two regions within YPG/LWBGR due to insufficient data. Recharge of the groundwater is supplied by infiltration of surface runoff and direct precipitation and by underflow from bordering areas. Discharge of groundwater occurs by evapotranspiration, by pumping and by underflow to the Gila and Colorado River Valleys.

2.4.2.2 Distribution and Use of Existing Wells and Groundwater Data

Approximately 72 active or abandoned wells exist within YPG/LWBGR (Figure 12). This includes wells located in excluded areas. No data are available for 19 of these wells and only limited data are available for the remaining wells (Appendix G). Those used for water or rock depth, or water quality determinations (39) are listed in Appendix G. Thirty-nine wells were plotted on the fifteen four-quad overlays (Hydrology, Y-I to Y-IV, Y-VI to Y-X, and Y-XII to Y-XV) in YPG/LWBGR. It was necessary to use wells located within excluded areas because of the lack of information in non-excluded areas. Wells located in excluded areas were used selectively and the data were extended to non-excluded areas based on geologic judgement of the validity of the extrapolation. The location of wells not used for data depiction are listed in Appendix G.

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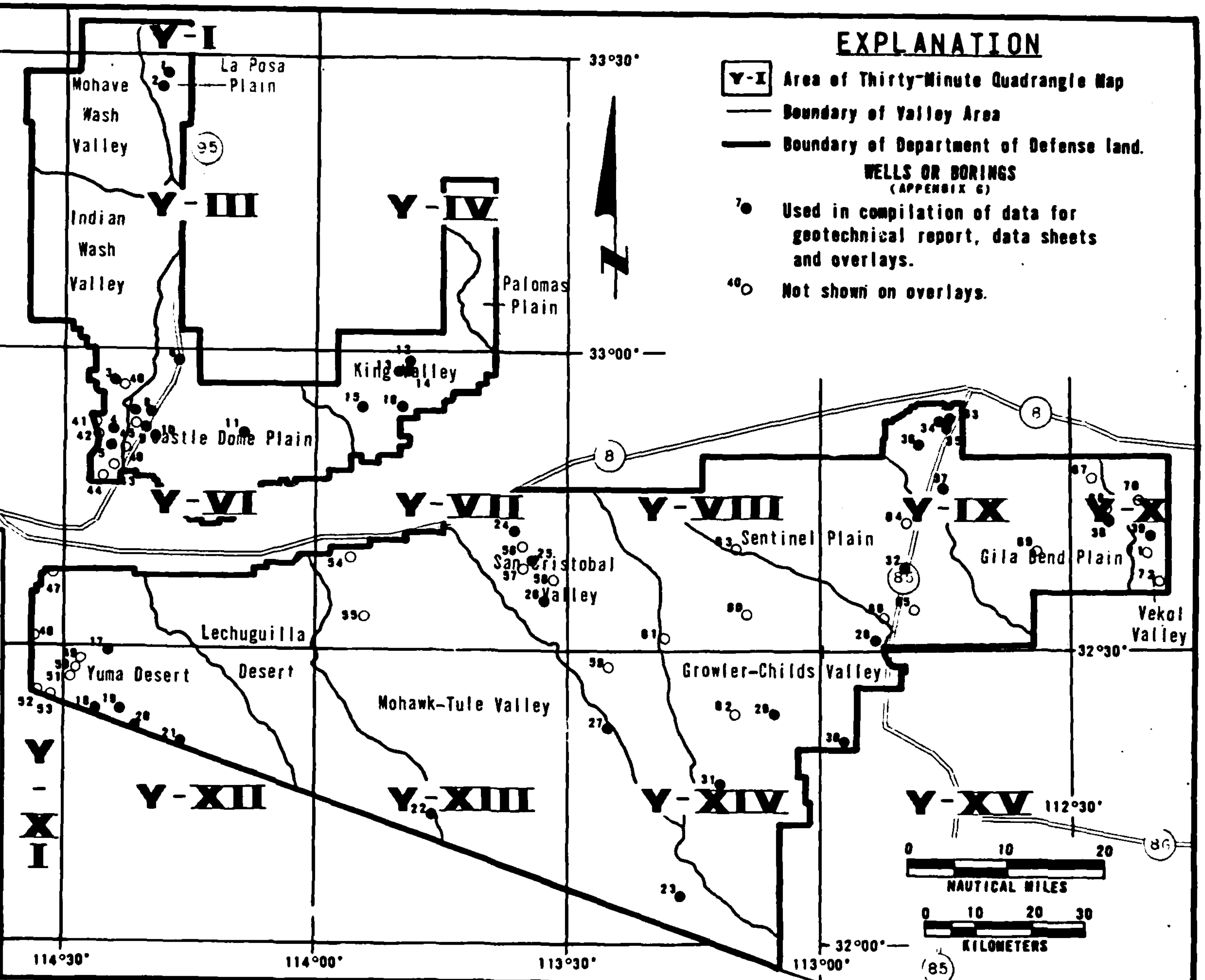

APPROXIMATE LOCATION OF WATER WELLS OR OTHER BORINGS

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FIGURE 12

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2.4.2.3 Groundwater in Basin-Fill Aquifers

Fresh groundwater supplies within YPG/LWBGR are found within the deeper basin fill. Locally as much as 3000 feet thick and consisting of lenses of gravel, sand, clay and silt, basin fill forms the major aquifer in YPG/LWBGR (Lower Colorado River State-Federal Interagency Group, 1971). The greatest and most consistent yields are obtained from a moderately cemented conglomerate (fanglomerate?) which usually overlies bedrock and is present in many of the basins in this area (Wilson, 1934; Metzger, 1968; Olmsted, 1972; Air Force Weapons Lab, 1973; and Olmsted and others, 1973).

In general, depth to groundwater within the basin fill decreases with decreasing distance from the Gila or Colorado Rivers. Depths range from 50 to 100 feet marginal to the Colorado River Valley in Mohave Wash Valley (Hydrology, Y-II) to at least 1000 feet in La Posa Plain in YPG (Hydrology, Y-III), and from 100 to 200 feet, marginal to the Gila River Valley, in north-central LWBGR (Hydrology, Y-VII, Y-VIII) to at least 600 feet in Sentinel Plain (Hydrology, Y-IX).

Water well yields from the basin fill are highly variable making it practically impossible to accurately predict groundwater yields from one well to another. This is a result of a complex depositional history which has resulted in vertical and lateral variations of the basin-fill deposits. Well yields in the basin-fill materials, for various casing and pump sizes, range from less than one to 1100 gallons per

minute (Stulik and Moosburner, 1969).

A confined basin-fill aquifer system, confined by clay or "claystone" deposits, is present in King Valley (Hydrology, Y-VII) at a depth of 785 to 985 feet, which is below the static groundwater level (U.S. Army Corps of Engineers, 1972a). Artesian conditions exist with approximately 150 feet of piezometric head above the base of the confining clay.

2.4.2.4 Perched Conditions

Caliche deposits and clay layers within the basin fill may produce perched groundwater conditions. Several local perched water zones have been recognized in YPG/LWBGR, and it is quite likely that many more are present. Perched zones were identified in La Posa Plain at depths of 400 to 450 feet and 650 to 700 feet (Turner, 1960), in King Valley at depths of 65 to 90 feet and 120 to 123 feet (U. S. Army Corps of Engineers, 1972a) and in San Cristobal Valley at a depth of 40 to 60 feet (Bryan, 1925). The amount of groundwater that can be obtained from these intervals depends on the areal extent and physical nature of these deposits, neither of which is well known.

2.4.2.5 Groundwater in Rock Aquifers

Groundwater in rock aquifers is unconfined in fractures within the basement rocks and confined within bedrock strata. Only four wells are known to tap rock aquifers in YPG/LWBGR. Wells deriving water from the basement fracture systems have been

reported to generally yield less than 500 gallons per day (Bryan, 1925). The only well known to tap a confined bedrock aquifer is in northwest Castle Dome Plain (T5N, R19W, Sec. 19; Click, 1970; Hydrology, Y-VI). The water-bearing stratum is at least 200 feet thick, and is probably a volcanic tuff which underlies a 600-foot thick sequence of volcanic bedrock. Artesian conditions exist with approximately 140-foot piezometric head above the base of the confining bedrock volcanics. Yields of greater than 350 gallons per minute were recorded during pumping tests (Click, 1970).

2.4.2.6 Water Quality

Chemical analyses of groundwater from wells in the siting area Valleys allowed a general separation of groundwater into fresh and saline water based on the amount of total dissolved solids (TDS) (Section 2.4.1.4, Table 8).

Only limited water quality analyses are available for wells within YPG/LWBGR (Appendix G). Water derived from basin-fill and rock aquifers is fresh water, with TDS ranging from 600 to 850 mg/l (Bryan, 1925; Cooley and Click, 1967; and Click, 1970); perched groundwater may be slightly saline, having 1000 to 1200 mg/l TDS (Bryan, 1925). A primary contaminant is fluoride, which ranges from less than 1.0 mg/l in rock aquifers to 9.0 mg/l in basin-fill aquifers. Other contaminants may be present in small amounts and include iron, nitrate, boron and arsenic (Lower Colorado River State-Federal Interagency Group, 1971).

2.4.2.7 Subsidence

Subsidence due to withdrawal of fluids from the ground has not been studied within YPG/LWBGR. A potential for subsidence with possible surface expression such as earth cracks or earth fissures exists within the area depending on future lowering of groundwater levels (Omar Loeltz, oral communication, 1974). Subsidence has occurred in agricultural regions of Arizona and California where prolonged, heavy pumpage is accompanied by progressive drawdown of the groundwater table. Where subsidence has occurred in Arizona, it has generally equaled about four percent of the total groundwater decline, or four feet of subsidence per 100 feet of groundwater level decline with a minimum of 200 feet groundwater level decline necessary for recognizable subsidence (Central Arizona Project, 1974).

No earth cracks have been reported within YPG/LWBGR, however, earth cracks have been reported in Arizona since 1927 and are located primarily within a 45 nm wide band trending northwest from Tucson toward Prescott, Arizona, within approximately 20 nm of YPG/LWBGR. These features have been extensively investigated (Leonard, 1929; Heindl and Feth, 1955; Pashley, 1961; Robinson and Peterson, 1962; Winikka, 1964; Kam, 1965; Poland, 1967; Poland and Davis, 1969; Schumann and Poland, 1969; Mildner, 1970; Pope and others, 1972; Anderson, 1973; Bull, 1973; and Sumner, 1973). Alteration of the distribution of groundwater (i.e., from subsurface to surface), usually by pumping and irrigation, results in: 1) consolidation and

subsidence at depth due to dewatering and lowering of the groundwater level by pumping, and 2) rapid settlement of the near-surface material due to addition of water at the surface by irrigating (Winikka, 1964). Tensional stresses produced by shrinkage result in earth cracks or fissures along potential zones of weakness, such as at the interface between alluvial fan and undifferentiated surficial deposits (Bull, 1973a). These fissures have maximum reported lengths of seven nm and depths of 60 feet and generally coincide with linear zones of steep gravity gradients that may reflect buried fault scarps (Schumann and Poland, 1969). Initially, however, the fissures appear as narrow cracks one to six inches in width with vertical offsets of zero to 12 inches (Anderson, 1973) and are reported to have split concrete roads and curbings (Robinson and Peterson, 1962; Schumann and Poland, 1969). When earth cracks transect drainages, water entering the fissures is transmitted vertically and laterally along the crack causing gullying and slumping (Kam, 1965). Widths of eroded fissures are commonly five to ten feet, but may be as great as 20 feet (Anderson, 1973).

2.5 CLIMATOLOGY

2.5.1 GENERAL

Climatic conditions within YPG/LWBGR are primarily a result of its inland location and latitudinal position. These two factors combine to produce an arid to semi-arid climate, characterized by hot summers, mild winters, relatively low humidity and long periods of aridity separated by thunderstorms yielding intense rainfalls. Climatic conditions are fairly uniform throughout YPG/LWBGR, with local variations due primarily to elevation differences.

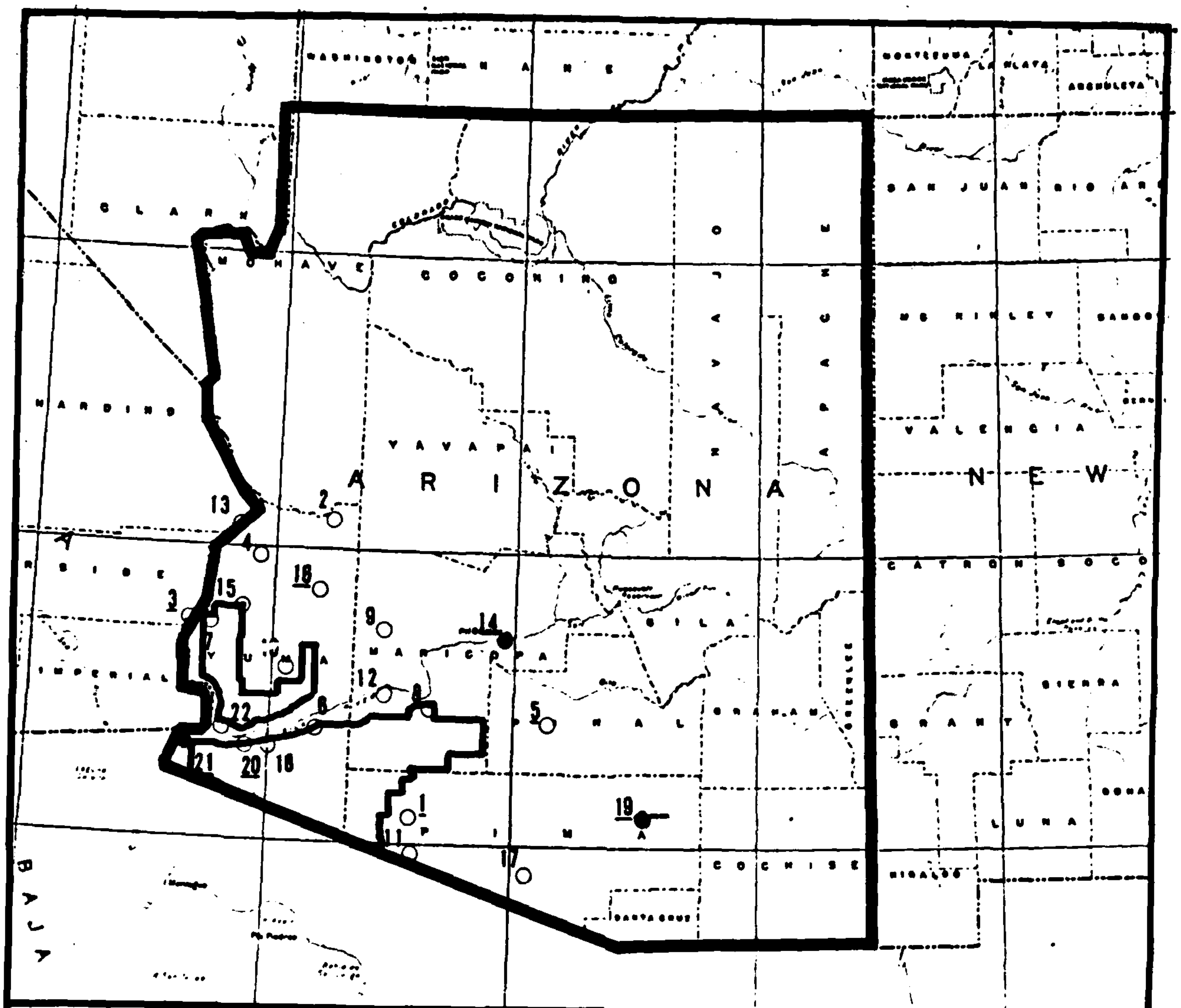
Table 13 lists the climatological recording stations in the vicinity of the YPG/LWBGR; the station locations are depicted in Figure 13. Climatological Data Summary Sheets (Appendix H) were compiled for selected recording stations within and adjacent to YPG/LWBGR (Figure 13) representing general climatic conditions within the area. Users of the Climatological Data Summary Sheets, tables, and text are reminded that conditions at locations other than the selected recording stations may be significantly different due to local terrain effects and elevation differences.

The primary sources for data presented on the Climatological Data Summary Sheets and summarized below are 1) the National Oceanic and Atmospheric Administration (NOAA) Environmental Data Service, and 2) the Arizona State Climatology Lab. The U. S. Army Research and Development Division (1953), Shepard and others (1955), Nelson (1957), Dodd and McPhilimy

TABLE 13

Climatological Recording Stations

Station Name	North Latitude	West Longitude	Elevation (ft.)	Years of Record
Ajo	32°22'	112°52'	1763	54
Alamo Dam 6ESE	34°16'	113°34'	1100	6
Blythe, California	33°37'	114°43'	395	32
Bouse	33°57'	114°01'	930	16
Casa Grande	32°53'	111°45'	1405	56
Dateland	32°48'	113°32'	445	12
Ehernberg	33°36'	114°32'	323	21
Gila Bend	32°57'	112°43'	737	42
Harquahala Plains # 1	33°30'	113°04'	1260	13
Kofa Mountains	33°16'	113°52'	1775	16
Organ Pipe Nat. Mon.	31°56'	112°47'	1678	25
Painted Rock Dam	33°05'	113°02'	550	10
Parker	34°10'	114°17'	425	56
Phoenix	33°26'	112°01'	1117	32
Quartzsite	33°40'	114°14'	870	9
Salome	33°47'	113°37'	1900	7
Sells	31°55'	111°53'	2375	30
Tacna	32°43'	113°55'	324	5
Tucson	37°07'	110°56'	2384	31
Wellton	32°40'	114°08'	260	38
Yuma	32°40'	114°36'	194	102
Yuma Proving Grounds	32°50'	114°24'	324	11



EXPLANATION

STATIONS

1 Ajo
2 Alamo Dam 6ESE
3 Blythe, Calif.
4 Bouse
5 Casa Grande
6 Dateland
7 Ehrenberg
8 Gila Bend
9 Harquahala Plains No.1
10 Kofa Mountains
11 Organ Pipe National Monument
12 Painted Rock Dam
13 Parker
14 Phoenix
15 Quartzite
16 Salome
17 Sells
18 Tacna
19 Tucson
20 Wellton
21 Yuma
22 Yuma Proving Ground

0 50 100 150
NAUTICAL MILES

0 100 200
KILOMETERS

SYMBOLS

Boundary of Department of Defence land.
19 ● Major recording stations
9 ○ Recording substations
3 Records compiled on data sheets.

LOCATION OF CLIMATOLOGICAL RECORDING STATIONS

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE 13

FUGRO NATIONAL, INC.

DATE: 30 JUNE 1975

(1959), Ohman and Pratt (1966), and Anderson and Italia (1970) also provide descriptive summaries of the regional climatic conditions at YPG.

2.5.1.1 Precipitation

The low mean annual precipitation of YPG/LWBGR is controlled by 1) the inland location of the area, 2) the rain-shadow effect of the mountain ranges of the west coast of the U. S., and 3) the north-south trending mountain ranges within the siting area. Precipitation occurs principally in the months of July, August and September and December, January and February, and is generally in the form of rain, although traces of snow have been recorded throughout YPG/LWBGR. Generally, the western area has less average annual rainfall (3.48 inches at Yuma) than the area to the east (5.47 inches at Gila Bend and 8.86 inches at Ajo) where elevations are also generally higher.

August is statistically the month of heaviest rainfall, although approximately two-thirds of the total annual precipitation occurs during the winter months. Summer rains usually result from local thunderstorms; while in the winter, gentler rains over a large area are more common. As much as 2.0 inches of precipitation in a 15-minute period has been recorded at Gila Bend Auxiliary Field during a summer thunderstorm (Anderson and Italia, 1970).

2.5.1.2 Wind

Wind direction is variable within YPG/LWBGR. In the eastern portion, westerly winds predominate during the summer and easterly winds prevail during the remainder of the year with wind speeds averaging about 10 miles per hour (mph). In the western portion, southerly winds predominate during the summer and northerly winds prevail during the remainder of the year, with wind speeds averaging five to six mph. Maximum wind gusts of 50 to 60 mph are recorded in the valleys primarily during the early spring.

2.5.1.3 Temperature

From mid-May to mid-September the daytime temperature in YPG/LWBGR generally exceeds 100 degrees Farenheit (^{o}F), with nighttime temperatures usually in the sixties, but often remaining above 90^{o}F during June, July and August. Summer soil temperatures may reach 140^{o}F or greater, dropping to 80^{o}F at night. Winters are mild with daytime temperatures averaging between 50 and 60^{o}F, dropping to the mid-thirties at night. A frost-free period of ten to eleven months is common throughout most of the area, with frost usually occurring in December and January.

2.5.1.4 Barometric Pressure

Daily and monthly average barometric pressure data are available for Phoenix and Yuma, Arizona. Average seasonal levels of station pressure (in inches of mercury) for Phoenix and Yuma, respectively, are: winter 28.89 and 29.85; spring - 28.73

and 29.66; summer - 28.65 and 29.55; and autumn - 28.78 and 29.69. The mean annual station pressure for 1974 is 28.76 inches at Phoenix and 29.69 inches at Yuma. With Phoenix at 1117 feet elevation and Yuma at 199 feet, and with barometric pressure varying approximately one inch per 950 feet of altitude (Strahler, 1962), these values approximate the range of average barometric pressure for approximately 90 percent of the less than ten percent grade area of YPG/LWBGR.

2.5.1.5 Relative Humidity and Evaporation Rate

With an average of approximately 330 and 350 days (90 and 97 percent) of sunshine in the eastern and western portions of YPG/LWBGR, respectively, and relative humidity of less than 35 percent, the evaporation rate is very high. Pan evaporation has been measured as 120 inches at YPG (Shepard and others, 1955), or roughly 25 times the average precipitation.

2.5.2 SEVERE WEATHER CONDITIONS

2.5.2.1 General

Severe weather conditions included here are unusual weather phenomena and are not extremes of the standard climatological parameters recorded in the Climatological Data Summary Sheets (Appendix H).

2.5.2.2 Fog

Fog may develop over the western portion of YPG/LWBGR, particularly during the months of December, January and February, when reversal of the normal winter wind pattern may draw warm, moist air in from the Gulf of California.

Although usually of short duration (less than five hours), the resulting fog may limit visibility to as little as one nm.

2.5.2.3 Thunderstorms

Thunderstorms in southwestern Arizona occur on an average of 15 days per year, primarily during the months of July through September. They result in intense rainfalls (as much as 2.0 inches within 15 minutes; Section 2.5.1.1) and may be accompanied by lightning, high winds, dust storms, tornados and funnel clouds, or hail. No data on average geographic extent or intensity of these thunderstorms are available.

2.5.2.4 Dust Storms

High winds (up to 60 mph) that accompany thunderstorms and low pressure storm fronts passing through the area may pick up dust and sand, creating local dust storms that can limit visibility to zero in the affected area. Presently, there is insufficient data available to determine the intensity or duration of these local storms. Studies are being conducted at YPG to obtain quantitative data describing these storms and their effects (Arthur Bell, oral communication, 1974).

2.5.2.5 Tornados and Funnel Clouds

Tornados and funnel clouds may accompany severe thunderstorms. Since 1960, only three tornados have been reported in the vicinity of YPG/LWBGR; these reports originated in Yuma on 13 September, 1966, in Casa Grande on 16 July, 1967 and in Hyder (15 nm east of YPG; latitude 33°N) on 4 October, 1972

(National Weather Service, 1966a, 1967, 1972). During the same period, funnel clouds were sighted over Gila Bend on 4 October, 1966 and over Ajo on 13 February, 1968 (National Weather Service, 1966b, 1968). There is insufficient data available to determine the intensity or duration of these phenomena.

2.5.2.6 Hail

Hail may accompany severe thunderstorms. Since 1960, there have been only four reports of hail 0.5 inches in diameter or greater in the vicinity of YPG/LWBGR. These reports originated in Gila Bend on 15 August, 1960 (1.0 inch), in Yuma on 1 November, 1963 (0.9 inch) and on 28 April, 1964 (1.5 inches), and in Casa Grande on 16 July, 1967 (0.5 inch) (National Weather Service, 1960, 1963, 1964, 1967).

2.5.2.7 Tropical Storms

From August through October, tropical cyclonic storms (counter-clockwise similar to hurricanes) occur over the Pacific Ocean off the coast of Baja, Mexico. These tropical storms generally dissipate rapidly as they move inland. However, from 3 October to 7 October, 1972 tropical storm "Joanne" moved across Arizona. This is believed to be the first time in the recorded history of the state that a tropical storm has entered Arizona with its cyclonic air circulation intact (National Weather Service, 1972). The storm produced abundant precipitation (between two and three inches), resulting in extensive flooding and sustained wind speeds of 35 to 40 mph

across southern Arizona. Tornados were reported in association with local thunderstorms that developed within the tropical storm system (Section 2.5.2.5).

2.6 TERRAIN ANALYSIS

2.6.1 GENERAL

The purpose of the terrain analysis is to rank qualitatively, using quantitative methods (Table 14; Section 2.6.3.1), the various geomorphic landforms (alluvial fans and bajadas, playas, pediments, sand dunes, and terraces) within YPG/LWBGR. Although movement of the land mobile system components will not necessarily be restricted to the existing terrain, a terrain analysis was applied to YPG/LWBGR due to terrain characteristics which may impose design limitations on, or greatly increase the cost of design and construction of the aim point or line concepts of the land mobile system. This analysis was performed on the entire siting area; however, it was not refined to the level of analyzing each Valley (Section 3.0) independently due to the lack of specific detailed data. The data and analyses presented in Table 14 are based upon limited ground (YPG) and aerial (LWBGR) reconnaissance field observations; review of aerial photographs (scale 1:30,000 for YPG; 1:60,000 for LWBGR); pertinent literature and topographic base maps (scale 1:62,500), and application of the terrain analysis techniques described by the U. S. Army Corps of Engineers for preparing desert terrain analogs (Yuma Test Station served as the base area for these analogs; van Lopik and Kolb, 1959).

The completed terrain analysis was then compared to similar terrain and surface materials studies conducted at YPG (Millet and Barnett, 1970; Barnett, 1975, in preparation).

Rating of the selected landforms is accomplished by;

1. Selecting the major factors to be analyzed based on surface geometry and near-surface soil characteristics believed critical;
2. Assigning a range of values which describes either quantitatively or qualitatively the individual factors which comprise the physical characteristics of the selected landforms;
3. Subdividing this overall range into three to six value ranges which were ranked (ordered) from most suitable (or lowest total) to least suitable (highest total) condition; and
4. Determining the characteristic factor value range and totaling the ranking values for each landform.

The resultant rating represents the cumulative analysis performed on all landforms. These results presented in Table 14 and Section 2.6.3 should not be considered a substitute for a more specific analysis based on field related studies.

2.6.2 FACTORS USED IN THE TERRAIN ANALYSIS

The selection of the major factors for the terrain analysis discussed in the subsections below, was based on surface geometry and near-surface soil properties believed critical in a terrain study. Many of the factors and value ranges may imply more detail than is available based on data collected in this initial phase of the study. Descriptions are intended to allow planning activities to proceed until further refinement of the factors can be made based on future field investigations.

YPG/LWBGR LANDFORMS		CHARACTERISTIC SLOPE IN PERCENT		Drainage Density (Topographic Texture)		CHANNEL CHARACTERISTICS Characteristic Relief Depth of Incision (Feet)		
		Value	Rank (1)	Value	Rank (2)	Value (Avg.)	Rank (3)	Max.
Alluvial Fans	Old Fans	>10	4	11-15	3	10-15	3	>20
	Intermediate	2-5	1	8-17	3	5-11	2	>20
	Young (YPG)	1-2.5	1	12->20	3	<5	1	10
	Bajadas (LWBGR)	.5-2.5	1	12->20	3	<5	1	10
Playas	Active Playas (1)	<.5	1	<5	1	<5	1	3
	Mantled Playas (2)							
	Pediments	3-3.5	1	6-8	2	6-9	2	>15
	Sand Dunes	>10	4	<5	1	<5	2	
Terraces	Lake (2)							
	River	.5	1	<5	1	<5	1	

Value Range	Rank	Value Range	Rank	Value Range	Ran
0-3.9	1	0-5	1	0-5	1
4.0-7.9	2	6-10	2	6-10	2
8-10	3	11-15	3	11-15	3
>10		16-20	4	16-20	4
		> 20	5	> 20	5

(1) Playas assumed to be wet.
(2) Not identified in YPG/LWBGR.

...L CHARACTERISTICS							PLAN PROFILE			
...teristic Relief of Incision (Feet)			Frequency of Slopes Greater than 50% (No/nm)		Peakedness		Planar Shape		Areal Occupan...	
Rank (3)	Max.	Min.	Value	Rank (4)	Value (a)	Rank	Value (b)	Rank	Value (c)	Ra...
3	>20	10	10-15	3	I	3	L	1	40-60%	
2	>20	<5	8-17	3	I	3	L	1	40-60%	
1	10	<1	<5	1	F	2	L	1	>60%	
1	10	<1	<5	1	N	1	L	1	>60%	
1	3	<1	0-2	1	N	1	N	3	>60%	
2	>15	<5	6-8	2	F	2	I	2	40-60%	
2			>20	5	C	4	I	2	<40%	
1			<5	1	F	2	I	2	>60%	

Value Range	Rank
0-5	1
6-10	2
11-15	3
16-20	4
> 20	5

Value Range	Rank
0-5	1
6-10	2
11-15	3
16-20	4
> 20	5

Value	Rank
No prominent highs or lows (N)	1
Flat-topped (F)	2
Intermediate (I)	3
Crested (C)	4

Value	Rank
Linear (L)	1
Intermediate (I)	2
Non-linear (N)	3

Value	Ra...
>60%	
40-60%	
<40%	

PLAN PROFILE						SOIL PROPERTIES			
Areal Occupance		Orientation		Plan Profile		CBR (in-situ)		AASHO Classifica	
Value (c)	Rank	Value (d)	Rank	Total = a+b+c+d	Rank (5)	Value	Rank (6)	Value	Rank (
40-60%	2	P	1	7	2	>20	1	A-1/A-2	1
40-60%	2	P	1	7	2	>20	1	A-1/A-2	1
>60%	1	P	1	5	1	>20	1	A-2/A-4	3
>60%	1	P	1	4	1	>20	1	A-2/A-4	3
>60%	1	R	3	8	3	<10	5	A-4/A-6	4
40-60%	2	P	1	8	3	>20	1	A-1/A-2	1
<40%	3	I	2	11	4	10-12	4	A-2	2
>60%	1	I	2	7	2	15-20	2	A-2/A-4	3

Value	Rank	Value	Rank	Total Value Range	Rank	Value Range	Rank	Value Range	Rank
>60%	1	Parallel (P)	1	4-5	1	>20	1	A-1 or A-2	1
40-60%	2	Intermediate (I)	2	6-7	2	19-15	2	A-2 or A-3	2
<40%	3	Random (R)	3	8-9	3	12-15	3	A-2 or A-4	3
				10-13	4	10-12	4	A-4 or A-6	4
						<10	5	A-6 or A-7	5

TABLE 14
YPG/LWBGR Terrain Analysis

...le	SOIL PROPERTIES				TERRAIN ANALYSIS RATING	
	CBR (in-situ)		AASHO Classification			
Rank (5)	Value	Rank (6)	Value	Rank (7)	Rank = 1+2+3+4+5+6+7	Evaluation
2	>20	1	A-1/A-2	1	17	Poor
2	>20	1	A-1/A-2	1	13	Fair
1	>20	1	A-2/A-4	3	11	Good
1	>20	1	A-2/A-4	3	11	Good
3	<10	5	A-4/A-6	4	16	Poor
3	>20	1	A-1/A-2	1	11	Good
4	10-12	4	A-2	2	21	Very Poor
2	15-20	2	A-2/A-4	3	11	Good

Rank	Value Range	Rank	Value Range	Rank	Evaluation	
1	>20	1	A-1 or A-2	1	<12	Good
2	19-15	2	A-2 or A-3	2	12-16	Fair
3	12-15	3	A-2 or A-4	3	16-20	Poor
4	10-12	4	A-4 or A-6	4	> 20	Very Poor
	<10	5	A-6 or A-7	5		

Whenever value ranges for a factor overlap two rankings (Table 14), the predominant value was used; if near equal, the more conservative (higher) value was used.

2.6.2.1 Slope Characteristics

A slope may be defined as a surface identified or designated in terms of its angle with the horizontal given in percent as the tangent of the angle. The characteristic slope of the major landforms in YPG/LWBGR is based upon the topographic grade as determined by the average contour interval and topographic expression. Values ranging from 0% to 10% were rated (Table 14). Characteristic slopes of the major landform surfaces typically range as follows: alluvial fans, 0% to 10%; pediments, 0% to 5%; playas and terraces, 0% to 2%; the upper reaches of alluvial fans and pediments near the mountain front exceed 10%; and sand dunes may exceed 10%.

2.6.2.2 Channel Characteristics

Drainage density (topographic texture), characteristic channel relief (in terms of depth of incision) and frequency of channel slopes exceeding 50% are the channel characteristics utilized in this terrain analysis.

The density of drainages is defined as the number of distinct drainages per nautical mile using available topographic maps and aerial photographs. The ratings in Table 14 for drainage density have been adjusted to reflect reconnaissance field observations and data available in the literature.

2.6.2.3 Characteristic Plan Profile

The characteristic plan profile is defined as the most common geometric profile found within the region based upon selective sampling in the area. It is the typical profile a landform may possess. Major elements of the plan profile (Figure 14) are:

1. The peakedness or degree and extent of the highs versus the low areas;
2. The planar shape of the landform highs (linear, intermediate, or non-linear);
3. The areal occupance of the crests or peaks as opposed to the lowlands; and
4. The degree of alignment of these landforms to each other (parallel, intermediate, or random).

2.6.2.4 Soil Properties

The terrain parameters discussed in Sections 2.6.2.1 through 2.6.2.3 deal primarily with the geometric configuration of individual landforms. Using only the geometric elements in a terrain analysis would result in a high rating for some landforms even though their near-surface soil conditions may make them less suitable. In order to adjust for this, two soil parameters were selected and applied: the California Bearing Ratio (CBR) and the AASHO classification (Appendix E).

Engineering judgement based upon the available soils information was used to estimate both the in situ CBR values and AASHO classification. The in situ CBR value gives an

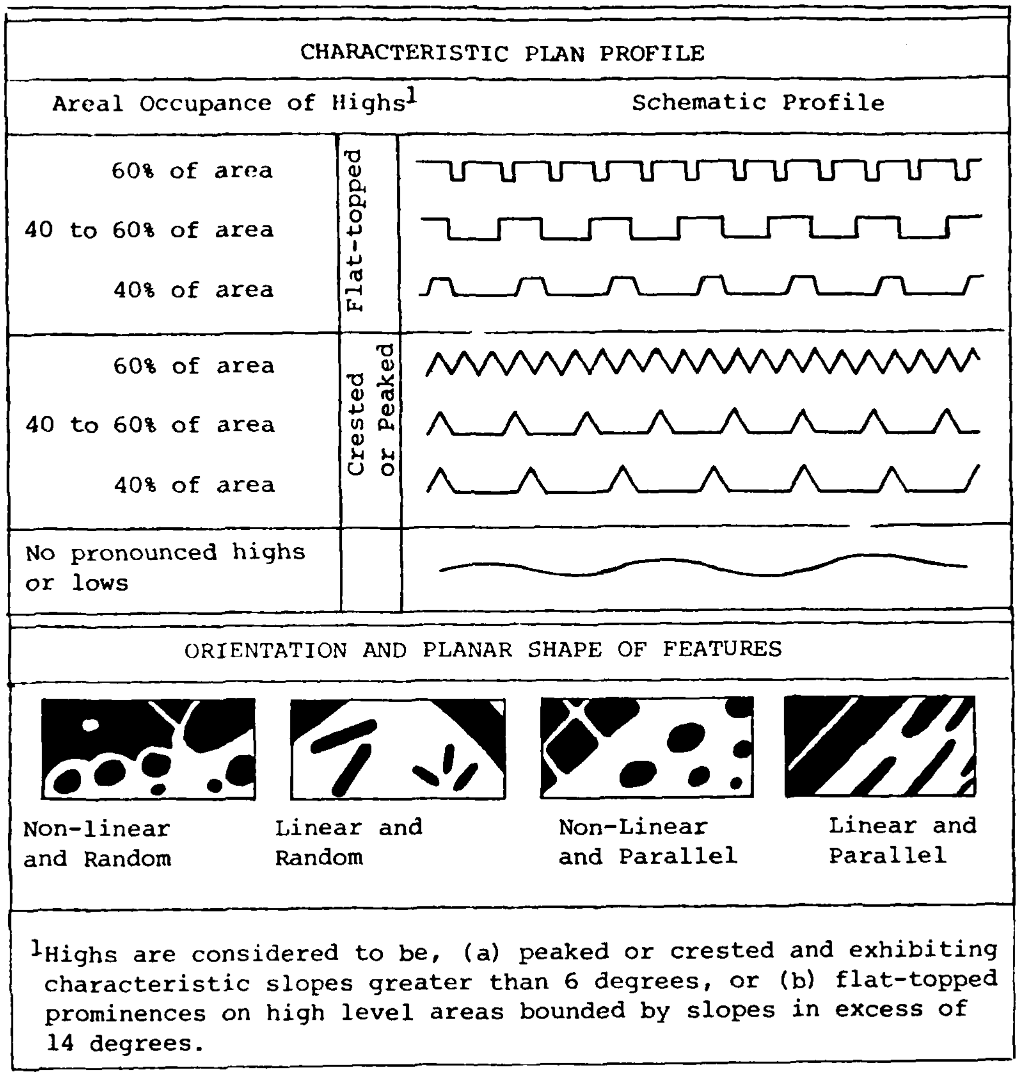


Figure 14. The characteristic plan profile is the typical geometric profile of a landform (van Lopik and Kolb, 1959).

indication of near-surface soil strength; values exceeding 20 are assumed to be acceptable or would require minimal strength improvement to support loads imposed by an overland system. CBR values less than ten are considered unacceptable.

In addition to CBR values, an AASHO classification, estimating the expected performance of near-surface materials as to workability, shrink-swell potential, shear strength, and relative drainage characteristics, was assigned. AASHO classifications A-1 and A-2 indicate materials that are assumed to be acceptable for use as subgrade, with A-6 and A-7 indicating unacceptable materials.

2.6.3 RESULTS

2.6.3.1 Evaluation Summary

Surface materials and terrain features have been studied in YPG (Millet and Barnett, 1970; Barnett, 1975, in preparation). These two studies examined geologic, geomorphic, topographic and terrain characteristics of the alluvial areas to determine their suitability for materiel testing. The following methods were used: 1) reconnaissance geologic mapping, 2) slope traverses (level surveys), 3) aerial photographic interpretation, 4) topographic map interpretation, and 5) selected soil sampling and testing, resulting in a series of 15-minute maps depicting the surficial materials and terrain features within YPG. In general, where the portions of YPG mapped on the Geology overlays coincide with maps delineating the surface materials and terrain features (Millet and Barnett, 1970; Barnett, 1975, in preparation), the units

correspond, and thus reinforce the terrain ratings independently derived in this study (Table 14) for the various landforms present within YPG/LWBGR.

The overall terrain analysis rating was divided into four categories: Good, Fair, Poor and Very Poor. A good rating indicates that, in general, movement or construction of the land-based system would be feasible based upon the presence of favorable slope and channel characteristics, and upon the judgement of favorable, near-surface soil conditions. A Very Poor rating indicates that unfavorable slope, channel and near-surface material characteristics may prohibit or greatly restrict development of the system. Fair and Poor are intermediate ratings and reflect a combination of favorable and unfavorable characteristics.

Alluvial fan ratings range from Good to Poor. The old fans ($A5_T$) are rated Poor due to unfavorable channel and plan-profile characteristics. The intermediate fans ($A5_Q$) are rated Fair due to unfavorable characteristic slope and channel characteristics. The young fans and bajadas ($A5_Q$) which are the predominant landforms within YPG/ LWBGR are rated Good due to the favorable nature of all factors evaluated.

Playas (assumed to be wet) are evaluated as Poor due primarily to their undesirable near-surface soil properties.

Pediments are rated as Good because of the favorable nature of almost all factors evaluated.

Sand dunes and those areas of appreciable sand accumulation, thickness and extent are rated Very Poor due to unfavorable characteristic slope and plan profile and near-surface soil properties.

Terraces, which have a very limited areal extent, are rated Fair due to their less favorable plan profile and near-surface soil properties.

2.6.3.2 Use of the Terrain Evaluation

The terrain analysis examines one important geotechnical aspect of MX siting. It combines an evaluation of critical geomorphic elements, such as drainage density and landform and channel morphology, with near-surface soil properties. It includes none of the other geotechnical constraints, which also have to be considered in the overall analysis of siting suitability, and no direct evaluation of the relationship of construction problems or cost related constraints.

3.0 VALLEY ANALYSIS

3.1 GENERAL

The Valley Analysis Concept discussed in this section was devised to allow for presentation of geotechnical data in a useful and uniform manner unique to an individual Valley. The data are presented on Data Summary Sheets which are to be used in conjunction with the general text and the pertinent four-quad overlays. Table 15 shows the Valleys, their total land areas, the area of the siting valley (based entirely on ten percent topographic grade exclusion and major cultural and quantity-distance exclusions), and the four-quad sheet, or portion of four-quad sheets (and overlays) which the Valley occupies.

3.2 VALLEY ANALYSIS SECTIONS AND DATA SUMMARY SHEETS

Sections 3.3 through 3.16 describe the fourteen individual Valleys which compose YPG/LWBGR. Each of these sections consist of:

1. A color topographic base map (scale 1:250,000; 1 inch = approximately 3.5 nm) showing the Valley boundary, the ten percent topographic grade exclusion and major cultural and quantity-distance exclusions (siting valley); and
2. Five data sheets which appear in the following order:
   a. Ownership and Cultural Features
   b. Topography and Geology
   c. Soils Engineering

TABLE 15

Designated Valleys in YPG/LWBGR Siting Area

Valley Name	Text Section	Total Valley Area (nm^2)	Area of Siting Valley (nm^2)	Applicable Four-Quad
La Posa Plain	3.3	61	30	Y-I,Y-II
Mohave Wash Valley	3.4	133	78	Y-I,Y-II,Y-III
Indian Wash Valley	3.5	324	69	Y-II,Y-III,Y-VI
Castle Dome Plain	3.6	321	157	Y-III,Y-VI,Y-VII
King Valley	3.7	184	134	Y-IV,Y-VII
Palomas Plain	3.8	67	39	Y-IV
Yuma Desert	3.9	314	111	Y-V,Y-VI,Y-XI, Y-XII
Lechuguilla Desert	3.10	330	255	Y-VI,Y-VII,Y-XII, Y-XIII
Mohawk-Tule Valley	3.11	853	683	Y-VI,Y-VII,Y-VIII, Y-XIV
San Cristobal Valley	3.12	353	319	Y-VII,Y-VIII,Y-XIII Y-XIV
Growler-Childs Valley	3.13	603	499	Y-VIII,Y-IX,Y-XIV, Y-XV
Sentinel Plain	3.14	385	322	Y-VIII,Y-IX
Gila Bend Plain	3.15	321	194	Y-IX,Y-X
Vekol Valley	3.16	71	23	Y-X
	Totals	4320	2913	

d. Surface Hydrology

e. Groundwater Hydrology

The data presented on these Data Summary Sheets include data obtained from the literature, aerial photographic interpretations, observations made during the brief field reconnaissance of the area and personal communications with individuals having specific knowledge or expertise in the Valley area. Quality of data is presented at the left-hand margin and indicates:

1. Darkened circle - data derived from detailed studies,
2. Half-darkened circle - estimated values, generally either extrapolations from detailed studies or estimates from general studies, and
3. Open circle - insufficient data available for extrapolation, or no data known to exist.

The REMARKS section may contain numerical quantitities (%; nm^2) where they are the primary response to the DESCRIPTION; a "0" (zero) numerical quantity indicates that the DESCRIPTION does not occur in that Valley. Quantity units (nm^2; ft.) are indicated in the REMARKS section only when they differ from those given in the DESCRIPTION. Blank spaces indicate that no data exist or that no data are available. Where conditions or features listed in the DESCRIPTION are known not to exist, "None" is entered under the REMARKS. Subheadings, which do not apply, are designated by "N/A." Abbreviations used on the Data Summary Sheets are listed in Table 16.

QUALITY OF DATA	DESCRIPTION		
	A. VALLEY AREA, OWNERSHIP AND LAND UTILIZATION		
●	1. Area of Valley	$61nm^2$	100
●	a. Area of valley excluded by major cultural or quantity-distance exclusions and 10% grade exclusion	$31nm^2$	51
●	2. Area of Siting Valley (A.1 minus A.1.a)	$30nm^2$	49
●	3. Ownership	DoD, U.S. A	
●	a. Portion of siting valley with direct DoD ownership	$30nm^2$	100
●	b. Co-owners or administrators of co-use land/ constraints	Small tract for state o	
◐	4. Contiguous BLM or Co-Use Land (area in nm^2)	<2000	BLM
◐	a. Relative location in or adjacent to valley	Adjacent to	
○	b. Present use		
	B. CULTURAL AND QUANTITY-DISTANCE EXCLUSIONS		
●	1. Location of 18 nm Arc (population greater than 25,000)	None	
●	2. Location of 3 nm Arc (population greater than 5,000)	None	
●	3. Other	None	
	C. CULTURAL IMPROVEMENTS		
◐	1. Roads/Railroads (name)	Unnamed roa	
◐	a. Relative location in valley	Randomly tr	
◐	b. Type and use	Unimproved,	
◐	2. Utilities (type)	None	
	a. Relative location in valley	N/A	
●	**D. MILITARY/GOVERNMENTAL USE AREAS**	Cibola Rang	
●	1. Location and areal extent (nm^2)	Non-rock po	
◐	2. Present use	None	
●	3. Future use	Anti-armor	
●	4. Decontamination necessary prior to siting	None	
	E. ADDITIONAL REMARKS		

Quality of Data

- ● Data derived from detailed studies
- ◐ Estimated values
- ○ Insufficient data available

IPTION			
D UTILIZATION	$61nm^2$	100%	
major cultural sions and 10%	$31nm^2$	51%	
1 minus A.1.a)	$30nm^2$	49%	
	DoD, U.S. Army, Yuma Proving Grounds		
ith direct DoD	$30nm^2$	100%	
rs of co-use land/	Small tracts (sections) periodically leased for short term (10 years) for state or private use (approximately 3 to 4%)		
Land (area	<2000	BLM (La Posa Plain) with minor state and private ownership	
djacent to valley	Adjacent to Valley east and north of YPG boundary		
E EXCLUSIONS			
opulation greater	None		
pulation greater	None		
	None		
	Unnamed roads and jeep trails		
ley	Randomly transect Valley		
	Unimproved; military and restricted civilian		
	None		
ley	N/A		
EAS	Cibola Range North (proposed)		
t (nm^2)	Non-rock portion of Valley; approximately 30 nm^2		
	None		
	Anti-armor test site (proposed)		
y prior to siting	None		

QUALITY OF DATA	DESCRIPTION
	A. TOPOGRAPHIC GRADIENT IN SITING VALLEY
●	1. Area with Less than 10% Grade
●	2. Area with 5 to 10% Grade
●	3. Area with 0 to 5% Grade
●	4. Location of Alluvial Passes or Valley Boundaries Having Less than 10% Grade
	B. ROCK CONDITIONS IN SITING VALLEY (BR=Basement, B=Bedrock, VF=Volcanic Flows)
◒	1. Exposed Rock (category/symbol/lithology
◒	a. Location and map area in nm^2
○	b. Seismic velocity (p/s in fps)
	c. Conditions of volcanic flow
◒	2. Pediments (rock type)
	a. Location and map area in nm^2
	b. Exposure condition
	c. Distance into siting valley from rock exposures (max./min./avg.) (nm)
	C. SUBSURFACE ROCK CONDITIONS IN SITING VALLEY (BR=Basement, B=Bedrock, VF=Volcanic Flows)
	1. Depth to Rock (map area in nm^2)
○	a. 0 to 250 feet (excluding pediments)
○	1) Type
○	2) Seismic velocity (p/s in fps)
○	b. 250 to 500 feet
○	1) Type
○	2) Seismic velocity (p/s in fps)
◒	c. 500 to 1000 feet
◒	1) Type
○	2) Seismic velocity (p/s in fps)
◒	d. Greater than 1000 feet
◒	1) Type
○	2) Seismic velocity (p/s in fps)
○	e. Unknown

Quality of Data

● Data derived from detailed studies
◒ Estimated values
○ Insufficient data available

TOPOGRAPHY AND
3.3.2 La Posa Pla

O N			
Y	30nm^2	100%	
	3nm^2	10%	
	27nm^2	90%	
Valley Grade	Southern end of Valley connects with Mohave Wash Valley by Gould Wash and Felipe Pass.		
c Flows) lthology)	B/I2$_T$/andesitic to basaltic volcanics; B/S$_{MP}$/sandstone, shale, conglomerate, limestone		
	1	3%	Along flanks of Trigo Peaks and Castle Dome Mountains west and south side
	N/A		
	None		
	0	0	N/A
	N/A		
rock	N/A		
G VALLEY c Flows))			
s)			See Additional Remarks (a)
)			
			See Additional Remarks (a)
)			
	13	43%	
)			
	16	54%	
)			

m^2	100%	
m^2	10%	
m^2	90%	
uthern end of Valley connects with Mohave Wash Valley by Gould sh and Felipe Pass.		
/I2$_T$/andesitic to basaltic volcanics; B/S$_{MP}$/sandstone, shale, conglomerate, limestone		
	3%	Along flanks of Trigo Peaks and Castle Dome Mountains west and south sides of Valley
A		
ne		
0	0	N/A
/A		
/A		
		See Additional Remarks (a)
		See Additional Remarks (a)
13	43%	
16	54%	

QUALITY OF DATA	DESCRIPTION		
○	2. Rock (Section 2.2.3) in Basin-Fill Deposits (map area in nm^2)		
○	a. Type		
○	b. Depth to (ft.)		
○	c. Thickness (ft.)		
○	d. Seismic velocity (p/s in fps)		
	D. BASIN-FILL DEPOSITS IN SITING VALLEY		
●	1. Undifferentiated Deposits (A; map area in nm^2)	16	54%
○	a. Thickness (max./min./avg. in ft.)		
◒	b. Lithology	Sand, silt, g	
○	c. Seismic velocity (p/s in fps)		
●	2. Alluvial Fan Deposits (A_5; map area in nm^2)	13	43%
○	a. Thickness (max./min./avg. in ft.)		
◒	b. Lithology	Sand, silt, g	
○	c. Seismic velocity (p/s in fps)		
●	3. Playa Deposits (A_4; map area in nm^2)	0	0
	a. Thickness (max./min./avg. in ft.)	N/A	
	b. Lithology	N/A	
	c. Seismic velocity (p/s in fps)	N/A	
●	4. Wind-blown Sand (A_3; map area in nm^2)	0	0
	a. Thickness (max./min./avg. in ft.)	N/A	
	b. Lithology	N/A	
	c. Seismic velocity (p/s in fps)	N/A	
●	5. Pediment Deposits (A_6; map are in nm^2)	0	0
	a. Thickness (max./min./avg. in ft.)	N/A	
	b. Lithology	N/A	
	c. Seismic velocity (p/s in fps)	N/A	
●	6. Stream Channel and Floodplain Deposits (A_1; map area in nm^2)		
○	a. Thickness (max./min./avg. in ft.)		
○	b. Lithology		
○	c. Seismic velocity (p/s in fps)		

Quality of Data

● Data derived from detailed studies

◒ Estimated values

○ Insufficient data available

332-A

CRIPTION			
) in Basin-Fill Deposits			
/s in fps)			
SITING VALLEY posits (A; map area	16	54%	
ı./avg. in ft.)			
	Sand, silt, gravel		
ı/s in fps)			
ts (A_5; map area in nm^2)	13	43%	
ı./avg. in ft.)			
	Sand, silt, gravel		
ı/s in fps)			
map area in nm^2)	0	0	
ı./avg. in ft.)	N/A		
	N/A		
ı/s in fps)	N/A		
; map area in nm^2)	0	0	
ı./avg. in ft.)	N/A		
	N/A		
ı/s in fps)	N/A		
(A_6; map area in nm^2)	0	0	
ı./avg. in ft.)	N/A		
	N/A		
ı/s in fps)	N/A		
Floodplain Deposits 2)			Present, but not mappable at 1:62,500 scale
ı./avg. in ft.)			
(p/s in fps)			
s			

QUALITY OF DATA	DESCRIPTION		
●	7. Terrace Deposits (A_2; map area in nm^2)	0	0
	a. Thickness (max./min./avg. in ft.)	N/A	
	b. Lithology	N/A	
	c. Seismic velocity (p/s in fps)	N/A	
○	8. General Summary of Relationships		
	E. TECTONIC FRAMEWORK OF SITING VALLEY		
●	1. Capable or Potentially Capable Fault	None	
	a. Total length (nm)	N/A	
	b. Relative location	N/A	
	c. Type of faulting, regional and local attitudes (strike and dip)	N/A	
	d. Minimum age of displacement or seismic activity (y.b.p.)	N/A	
●	2. Volcanism	None	
	a. Volcanic flows	N/A	
	1) Location and map area in nm^2	N/A	
	2) Minimum age of volcanic activity (y.b.p.)	N/A	
	F. SEISMICITY OF SITING VALLEY (Regional seismicity discussed in Section 2.2.4 of text)		
◒	1. Relative Pre-Instrumental Historic Activity (Section 2.2.4)	None	
◒	2. Site Area Seismic Activity (instrumental, 1927-1973; Section 2.2.4)		
◒	a. Events (epicenters) greater than M=6.0	None	
◒	b. Events (epicenters) greater than M=1.0 and less than M=6.0	None	
○	c. Events less than M=1.0 (includes microearthquakes)		
◒	3. Maximum Reported Modified Mercalli Intensity	VI	
◒	4. Source of Possible Ground Acceleration Levels (Section 2.2.4)	Salton Trough (	
◒	a. Maximum credible level (g)	0.12	
◒	b. Most probable level (g)		
	G. Additional Remarks	(a) Area extent	

Quality of Data

● Data derived from detailed studies

◒ Estimated values

○ Insufficient data available

332-8

O N			
a nm2)	0	0	
	N/A		
	N/A		
	N/A		
ault	None		
	N/A		
	N/A		
cal attitudes	N/A		
ismic activity	N/A		
	None		
	N/A		
	N/A		
ity	N/A		
al seismicity ric Activity	None		
trumental,			
M=6.0	None		
M=1.0 and less	None		
microearthquakes)			
lli Intensity	VI		
eration Levels	Salton Trough (Zone 1)	Transition Zone (Zone 2)	Diffuse Seismicity (Zone 3)
	0.12	0.05	0.2
		0.05	
	(a) Area extent less than 1%; data insufficient for contouring.		

SOILS ENGINEERING PROPERTIES (1)	MAP UNIT NUMBER 28	MAP UNIT NUMBER 31
Unified soil classification (2)	GM,SM,ML	GM,SM,ML,CL
AASHO soil classification	A-1,A-2 or A-4	A-2,A-4 or A-6
Percent passing #4 sieve	40-95	95-100
Percent passing #40 sieve	40-65	30-85
Percent passing #200 sieve	25-50	20-75
Liquid limit/plasticity index	20-30/0-10	0-40/0-25
Surface consistency		
Dry density (pcf)		
Permeability (cm/sec)	10^{-1} to 10^{-3}	10^{-1} to 10
In-situ shear strength (psi)		
In-situ angle of internal friction (degrees)		
Cohesion (psi)		
Shrink-swell potential	Low	Low to moderate
Coefficient of compressibility (in^2/lb.)		
In-situ CBR		
Recompacted CBR		
General surface moisture condition		
Compressional wave velocities (fps)		
Shear wave velocities (fps)		
Deleterious substances	Sulfates present in some areas	
ENGINEERING DESIGN EVALUATIONS (1)		
Suitability as impermeable membrane when recompacted	Poor	Poor
Suitability as source of sand/fill material	Poor/Fair	Poor/Fair
Suitability as source of aggregate/base course	Fair/Fair	Poor/Poor
Near surface foundation design characteristics	Mod. strength	Mod. strength Mod. expan.
Excavation limitations and slope angle	Sloughing 45°-60°	Ravelling 45°-60°
Additional Remarks	Highly alkaline; corrosive to uncoated steel, possible sulfate corrosion of concrete; (A5$_Q$)	(A$_Q$)

Explanation

(empty box)	No literature available and data not extrapolated
(SP-SM)	No literature available and data extrapolated
SP-SM	Data available in literature

(1) Surface soils only, depth of less than 5 feet

(2) Related geologic unit(s) shown in Additional Remarks (e.g. Al$_Q$)

QUALITY OF DATA	DESCRIPTION	
	A. SURFACE WATER IN SITING VALLEY	
●	1. Playas; Intermittent and Perennial Lakes	None
	a. Duration of surface water (wks.)	N/A
	b. Maximum extent (nm2)	N/A
	c. Water depth (avg. in ft.)	N/A
	d. Source of water	N/A
	e. Water quality	N/A
◒	2. Springs	None
	a. Duration of flow (wks.)	N/A
	b. Estimated maximum flow rate (gpm/season)	N/A
	c. Water quality	N/A
◒	3. Rivers or Streams	Tyson Wash
◒	a. Rate (gpm) and duration of flow (wks.)	Ephemeral
○	b. Water quality	
	B. HYDROLOGIC CHARACT[illegible]ICS OF SITING VALLEY	
◒	1. Drainage Channel (PR=Primary; S=Secondary)	Tyson Wash (PR)
◒	a. Depth of incision (max./min./avg.; ft.)	/ / 6 to 8
○	b. Width (max./min./avg.; ft.)	
◒	c. Gradient (ft./mi.)	20
◒	d. Channel bottom characteristics	Sand, gravel, cobbles
◒	e. Channel cross-section (schematic)	
◒	f. Channel spacing (avg. in ft.)	Main channel
◒	g. Preliminary flood susceptibility rating (Section 2.4.1)	CF1
○	2. Preliminary Flood Susceptibility Rating of Major Landform Surfaces (Section 2.4.1)	
○	a. Undifferentiated deposits	
○	b. Alluvial fans	
○	c. Playas (active=a; mantled=m)	
○	d. Pediments	
○	e. Sand dunes	
○	f. Terraces (l=lake; r=river)	
	C. ADDITIONAL REMARKS	Observations are base interpretation of top

Quality of Data
- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

TION		
LLEY nd Perennial Lakes	None	
ter (wks.)	N/A	
	N/A	
t.)	N/A	
	N/A	
	N/A	
	None	
)	N/A	
rate (gpm/season)	N/A	
	N/A	
	Tyson Wash	Numerous unnamed streams
n of flow (wks.)	Ephemeral	Ephemeral
S OF SITING VALLEY rimary; S=Secondary)	Tyson Wash (PR)	Numerous unnamed washes (S)
x./min./avg.; ft.)	/ / 6 to 8	
; ft.)		
	20	15 to 20
teristics	Sand, gravel, cobbles	Sand, gravel
(schematic)		
in ft.)	Main channel	50 to 100
ceptibility rating	CP1	
ceptibility Rating of es (Section 2.4.1)		
sits		
tled=m)		
iver)		
	Observations are based mainly on a brief aerial reconnaissance and interpretation of topographic maps and aerial photographs.	

1 2

QUALITY OF DATA	D E S C R I P T I O N			
	A. DEPTH TO GROUNDWATER WITHIN BASIN-FILL MATERIAL IN SITING VALLEY (Map area in nm2)			
○	1. 0 to 50 feet			
○	a. 0 to 25 feet			
○	b. 25 to 50 feet			
○	2. 50 to 100 feet			
◒	3. Greater than 100 feet	16	53%	Approxi
◒	4. Unknown or not Present	14	47%	Unsatur
	B. AQUIFER CHARACTERISTICS IN VALLEY			
●	1. Type of Aquifer (B=Basin Fill; P=Perched; R=Rock; u=unconfined; c=confined)	Bu		
○	a. Map area and extent			
◒	b. Depth to aquifer (ft.)	Greater than 900		
◒	c. Thickness (ft.)			
◒	d. Composition	Sand and gravel		
○	e. Porosity (%)			
○	f. Specific yield (%)			
○	g. Transmissivity (ft.^{2}/day)			
○	h. Specific capacity (gpm/ft. of drawdown)			
○	i. Total pumpage (ac. ft./unit time)			
◒	j. Groundwater ownership rights	YPG		
	C. WATER BUDGET FOR VALLEY			
○	1. Total Recharge (ac. ft./unit time)			
○	2. Total Discharge (ac. ft./unit time)			
	D. ADDITIONAL REMARKS	(a) Perched water levels (450- and 650-foot dep		

Quality of Data
- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

IPTION			
THIN BASIN-FILL EY (Map area			
.			
et	16	53%	Approximately 900 to greater than 1000 feet
ent	14	47%	Unsaturated north of fault

IN VALLEY Basin Fill; P=Perched; d; c=confined)	Bu	P See Additional Remarks (a)	P See Additional Remarks (a)
t.)	Greater than 900	400	650
		50	50
	Sand and gravel	Sand and gravel	Sand and gravel
t.²/day)			
(gpm/ft. of drawdown)			
ft./unit time)			
hip rights	YPG	YPG	YPG
Y			
. ft./unit time)			
c. ft./unit time)			
	(a) Perched water levels caused by clay layers at 450- and 650-foot depths		
es			

QUALITY OF DATA	DESCRIPTION		
	A. VALLEY AREA, OWNERSHIP AND LAND UTILIZATION		
●	1. Area of Valley	$133nm^2$	100%
●	a. Area of valley excluded by major cultural or quantity-distance exclusions and 10% grade exclusion	$55nm^2$	41%
●	2. Area of Siting Valley (A.1 minus A.1.a)	$78nm^2$	59%
●	3. Ownership	DoD, U.S. Army, Yuma P	
●	a. Portion of siting valley with direct DoD ownership	$78nm^2$	100%
●	b. Co-owners or administrators of co-use land/ constraints	Small tracts (sections for state or private u	
◒	4. Contiguous BLM or Co-Use Land (area in nm^2)	<100	BLM
◒	a. Relative location in or adjacent to valley	Adjacent to Valley nor	
○	b. Present use		
	B. CULTURAL AND QUANTITY-DISTANCE EXCLUSIONS		
●	1. Location of 18 nm Arc (population greater than 25,000)	None	
●	2. Location of 3 nm Arc (population greater than 5,000)	None	
●	3. Other	None	
	C. CULTURAL IMPROVEMENTS		
◒	1. Roads/Railroads (name)	Unnamed roads and jeep	
◒	a. Relative location in valley	Randomly transect Vall	
◒	b. Type and use	Unimproved; military a	
◒	2. Utilities (type)	None	
	a. Relative location in valley	N/A	
●	D. MILITARY/GOVERNMENTAL USE AREAS	None	
	1. Location and areal extent (nm^2)	N/A	
	2. Present use	N/A	
	3. Future use	N/A	
	4. Decontamination necessary prior to siting	N/A	
	E. ADDITIONAL REMARKS		

Quality of Data

- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

CRIPTION			
LAND UTILIZATION	$133nm^2$	100%	
d by major cultural exclusions and 10%	$55nm^2$	41%	
(A.1 minus A.1.a)	$78nm^2$	59%	
	DoD, U.S. Army, Yuma Proving Grounds		
ley with direct DoD	$78nm^2$	100%	
rators of co-use land/	Small tracts (sections) periodically leased for short term (10 years) for state or private use (approximately 3%)		
Use Land (area	<100	BLM	
or adjacent to valley	Adjacent to Valley north and west of YPG boundary		
TANCE EXCLUSIONS (population greater	None		
(population greater	None		
	None		
)	Unnamed roads and jeep trails		
valley	Randomly transect Valley		
	Unimproved; military and restricted civilian		
	None		
valley	N/A		
AREAS	None		
tent (nm^2)	N/A		
	N/A		
	N/A		
sary prior to siting	N/A		

QUALITY OF DATA	DESCRIPTION		
	A. TOPOGRAPHIC GRADIENT IN SITING VALLEY		
●	1. Area with Less than 10% Grade	$78nm^2$	100%
●	2. Area with 5 to 10% Grade	$3nm^2$	4%
●	3. Area with 0 to 5% Grade	$75nm^2$	96%
●	4. Location of Alluvial Passes or Valley Boundaries Having Less than 10% Grade	Southeastern por Gould Wash and F	
	B. ROCK CONDITIONS IN SITING VALLEY (BR=Basement, B=Bedrock, VF=Volcanic Flows)		
●	1. Exposed Rock (category/symbol/lithology)	None	
	a. Location and map area in nm^2	0	0
	b. Seismic velocity (p/s in fps)	N/A	
	c. Conditions of volcanic flow	N/A	
◒	2. Pediments (rock type)	None	
	a. Location and map area in nm^2	0	0
	b. Exposure condition	N/A	
	c. Distance into siting valley from rock exposures (max./min./avg.) (nm)	N/A	
	C. SUBSURFACE ROCK CONDITIONS IN SITING VALLEY (BR=Basement, B=Bedrock, VF=Volcanic Flows)		
	1. Depth to Rock (map area in nm^2)		
●	a. 0 to 250 feet (excluding pediments)	78	100%
◒	1) Type	B	
○	2) Seismic velocity (p/s in fps)		
●	b. 250 to 500 feet	0	0
	1) Type	N/A	
	2) Seismic velocity (p/s in fps)	N/A	
●	c. 500 to 1000 feet	0	0
	1) Type	N/A	
	2) Seismic velocity (p/s in fps)	N/A	
●	d. Greater than 1000 feet	0	0
	1) Type	N/A	
	2) Seismic velocity (p/s in fps)	N/A	
●	e. Unknown	0	0

Quality of Data

● Data derived from detailed studies

◒ Estimated values

○ Insufficient data available

S C R I P T I O N			
IN SITING VALLEY			
han 10% Grade	78nm^2	100%	
0% Grade	3nm^2	4%	
% Grade	75nm^2	96%	
vial Passes or Valley g Less than 10% Grade	Southeastern portion of Valley connects with La Posa Plain by Gould Wash and Felipe Pass.		
G VALLEY ock, VF=Volcanic Flows) tegory/symbol/lithology)	None		
p area in nm^2	0	0	N/A
y (p/s in fps)	N/A		
olcanic flow	N/A		
type)	None		
p area in nm^2	0	0	
ion	N/A		
iting valley from rock ./min./avg.) (nm)	N/A		
DITIONS IN SITING VALLEY rock, VF=Volcanic Flows) map area in nm^2)			
(excluding pediments)	78	100%	
	B		
locity (p/s in fps)			
t	0	0	
	N/A		
locity (p/s in fps)	N/A		
et	0	0	
	N/A		
locity (p/s in fps)	N/A		
000 feet	0	0	
	N/A		
locity (p/s in fps)	N/A		
	0	0	
tudies			

QUALITY OF DATA	DESCRIPTION		
○	2. Rock (Section 2.2.3) in Basin-Fill Deposits (map area in nm^2)		
○	a. Type		
○	b. Depth to (ft.)		
○	c. Thickness (ft.)		
○	d. Seismic velocity (p/s in fps)		
	D. BASIN-FILL DEPOSITS IN SITING VALLEY		
●	1. Undifferentiated Deposits (A; map area in nm^2)	0	0
	a. Thickness (max./min./avg. in ft.)	N/A	
	b. Lithology	N/A	
	c. Seismic velocity (p/s in fps)	N/A	
●	2. Alluvial Fan Deposits (A_5; map area in nm^2)	70	88%
○	a. Thickness (max./min./avg. in ft.)		
◐	b. Lithology	Sand, silt,	
○	c. Seismic velocity (p/s in fps)		
●	3. Playa Deposits (A_4; map area in nm^2)	0	0
	a. Thickness (max./min./avg. in ft.)	N/A	
	b. Lithology	N/A	
	c. Seismic velocity (p/s in fps)	N/A	
●	4. Wind-blown Sand (A_3; map area in nm^2)	0	0
	a. Thickness (max./min./avg. in ft.)	N/A	
	b. Lithology	N/A	
	c. Seismic velocity (p/s in fps)	N/A	
●	5. Pediment Deposits (A_6; map area in nm^2)	0	0
	a. Thickness (max./min./avg. in ft.)	N/A	
	b. Lithology	N/A	
	c. Seismic velocity (p/s in fps)	N/A	
●	6. Stream Channel and Floodplain Deposits (A_1; map area in nm^2)	8	12%
○	a. Thickness (max./min./avg. in ft.)		
◐	b. Lithology	Sand, gravel	
○	c. Seismic velocity (p/s in fps)		

Quality of Data

● Data derived from detailed studies

◐ Estimated values

○ Insufficient data available

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DESCRIPTION			
ction 2.2.3) in Basin-Fill Deposits in nm^2)			
to (ft.)			
ess (ft.)			
c velocity (p/s in fps)			
EPOSITS IN SITING VALLEY entiated Deposits (A; map area	0	0	
ess (max./min./avg. in ft.)	N/A		
logy	N/A		
ic velocity (p/s in fps)	N/A		
Fan Deposits (A_5; map area in nm^2)	70	88%	
ess (max./min./avg. in ft.)			
logy	Sand, silt, gravel; may include fanglomerate		
ic velocity (p/s in fps)			
posits (A_4; map area in nm^2)	0	0	
ess (max./min./avg. in ft.)	N/A		
logy	N/A		
ic velocity (p/s in fps)	N/A		
wn Sand (A_3; map area in nm^2)	0	0	
ess (max./min./avg. in ft.)	N/A		
logy	N/A		
ic velocity (p/s in fps)	N/A		
Deposits (A_6; map area in nm^2)	0	0	
ess (max./min./avg. in ft.)	N/A		
logy	N/A		
ic velocity (p/s in fps)	N/A		
hannel and Floodplain Deposits area in nm^2)	8	12%	
ess (max./min./avg. in ft.)			
logy	Sand, gravel, silt		
ic velocity (p/s in fps)			

tailed studies

ilable

QUALITY OF DATA	DESCRIPTION	
●	7. Terrace Deposits (A_2; map area in nm^2)	0
	a. Thickness (max./min./avg. in ft.)	N/A
	b. Lithology	N/A
	c. Seismic velocity (p/s in fps)	N/A
○	8. General Summary of Relationships	
	E. TECTONIC FRAMEWORK OF SITING VALLEY	
●	1. Capable or Potentially Capable Fault	None
	a. Total length (nm)	N/A
	b. Relative location	N/A
	c. Type of faulting, regional and local attitudes (strike and dip)	N/A
○	d. Minimum age of displacement or seismic activity (y.b.p.)	N/A
●	2. Volcanism	None
	a. Volcanic flows	N/A
	1) Location and map area in nm^2	N/A
	2) Minimum age of volcanic activity (y.b.p.)	N/A
	F. SEISMICITY OF SITING VALLEY (Regional seismicity discussed in Section 2.2.4 of text)	
●	1. Relative Pre-Instrumental Historic Activity (Section 2.2.4)	None
◒	2. Site Area Seismic Activity (instrumental, 1927-1973; Section 2.2.4)	
◒	a. Events (epicenters) greater than M=6.0	None
◒	b. Events (epicenters) greater than M=1.0 and less than M=6.0	None
○	c. Events less than M=1.0 (includes microearthquakes)	
◒	3. Maximum Reported Modified Mercalli Intensity	VI
◒	4. Source of Possible Ground Acceleration Levels (Section 2.2.4)	Salton T
◒	a. Maximum credible level (g)	0.12
◒	b. Most probable level (g)	
	G. Additional Remarks	

Quality of Data
● Data derived from detailed studies
◒ Estimated values
○ Insufficient data available

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N			
nm^2)	0	0	
	N/A		
	N/A		
	N/A		
ult	None		
	N/A		
	N/A		
l attitudes	N/A		
ic activity	N/A		
	None		
	N/A		
	N/A		
y	N/A		
seismicity c Activity	None		
umental,			
6.0	None		
1.0 and less	None		
croearthquakes)			
i Intensity	VI		
ation Levels	Salton Trough (Zone 1)	Transition Zone (Zone 2)	Diffuse Seismicity (Zone 3)
	0.12	0.05	0.2
		0.05	

SOILS ENGINEERING PROPERTIES (1)	26	27
Unified soil classification (2)	(GM-SM)	GM-SM
AASHO soil classification	(A-1,A-2)	(A-1,A-2)
Percent passing #4 sieve		35-80
Percent passing #40 sieve		30-55
Percent passing #200 sieve		15-35
Liquid limit/plasticity index		NP/NP
Surface consistency		
Dry density (pcf)		
Permeability (cm/sec)		10^{-2} to 10^{-4}
In-situ shear strength (psi)		
In-situ angle of internal friction (degrees)		
Cohesion (psi)		
Shrink-swell potential		Low
Coefficient of compressibility (in^2/lb.)		
In-situ CBR		
Recompacted CBR		
General surface moisture condition		
Compressional wave velocities (fps)		
Shear wave velocities (fps)		
Deleterious substances	Caliche present	Caliche pres in some area
ENGINEERING DESIGN EVALUATIONS (1)		
Suitability as impermeable membrane when recompacted	(Poor)	Poor
Suitability as source of sand/fill material	(Fair)/(Fair)	Fair/Good
Suitability as source of aggregate/base course	(Fair)/(Fair)	Fair/Fair
Near surface foundation design characteristics	(High strength)	Mod. strengt Low comp.
Excavation limitations and slope angle	(Difficult ripping or blasting)	Sloughing an difficult ri
Additional Remarks	Highly cemented; ($A5_T$)	Highly alkal corrosive to uncoated ste ($A5_{QT}$; $A5_{CQ}$

Explanation

(blank box)	No literature available and data not extrapolated
(SP-SM)	No literature available and data extrapolated
SP-SM	Data available in literature

(1) Surface soils only, depth of less than 5 feet

(2) Related geologic unit(s) shown in Additional Remarks (e.g. Al_Q)

s(1)	MAP UNIT NUMBER			
	26	27	28	33
	(GM-SM)	GM-SM	GM,SM,ML	GM,SM,SP,ML,CL
	(A-1,A-2)	(A-1,A-2)	A-1,A-2 or A-4	A-2,A-4,A-6 or A-7
		35-80	40-95	45-100
		30-55	40-65	30-100
		15-35	25-50	50-100
		NP/NP	20-30/0-10	10-45/NP-30
		10^{-2} to 10^{-4}	10^{-1} to 10^{-3}	10^{-2} to 10^{-4}
n (degrees)				
		Low	Low	Low to moderate
n²/lb.)				
n				
s)				
	Caliche present	Caliche present in some areas	Sulfates present in some areas	
NS(1)				
ne when recompacted	(Poor)	Poor	Poor	Fair to Poor
l material	(Fair)/(Fair)	Fair/Good	Poor/Fair	Fair/Fair
e/base course	(Fair)/(Fair)	Fair/Fair	Fair/Fair	Fair/Fair
aracteristics	(High strength)	Mod. strength Low comp.	Mod. strength	Low strength Mod. comp.
angle	(Difficult ripping or blasting)	Sloughing and/or difficult ripping	Sloughing 45°-60°	45°-60°
Additional Remarks	Highly cemented; ($A5_T$)	Highly alkaline; corrosive to uncoated steel; ($A5_{QT}$; $A5_{CQ}$)	Highly alkaline; corrosive to uncoated steel; possible sulfate corrosion to concrete; ($A5_Q$)	Subject to flooding; (A_Q)

e and data not extrapolated
e and data extrapolated
rature
depth of less than 5 feet
it(s) shown in Additional

QUALITY OF DATA	DESCRIPTION	
	A. SURFACE WATER IN SITING VALLEY	
●	1. Playas; Intermittent and Perennial Lakes	None
	a. Duration of surface water (wks.)	N/A
	b. Maximum extent (nm^2)	N/A
	c. Water depth (avg. in ft.)	N/A
	d. Source of water	N/A
	e. Water quality	N/A
◒	2. Springs	None
	a. Duration of flow (wks.)	N/A
	b. Estimated maximum flow rate (gpm/season)	N/A
	c. Water quality	N/A
◒	3. Rivers or Streams	Ehrenber
◒	a. Rate (gpm) and duration of flow (wks.)	Ephemera
○	b. Water quality	
	B. HYDROLOGIC CHARACTERISTICS OF SITING VALLEY	
◒	1. Drainage Channel (PR=Primary; S=Secondary)	Ehrenber
○	a. Depth of incision (max./min./avg.; ft.)	
◒	b. Width (max./min./avg.; ft.)	300-350/
◒	c. Gradient (ft./mi.)	100
◒	d. Channel bottom characteristics	Sand, gr
◒	e. Channel cross-section (schematic)	
◒	f. Channel spacing (avg. in ft.)	Primary
◒	g. Preliminary flood susceptibility rating (Section 2.4.1)	
○	2. Preliminary Flood Susceptibility Rating of Major Landform Surfaces (Section 2.4.1)	
○	a. Undifferentiated deposits	
○	b. Alluvial fans	
○	c. Playas (active=a; mantled=m)	
○	d. Pediments	
○	e. Sand dunes	
○	f. Terraces (l=lake; r=river)	
	C. ADDITIONAL REMARKS	Observat interpre

Quality of Data

● Data derived from detailed studies

◒ Estimated values

○ Insufficient data available

	None				
	N/A				
	N/A				
	N/A				
	N/A				
	N/A				
	None				
	N/A				
	N/A				
	N/A				
	Ehrenberg Wash	Gould Wash	Mohave Wash	Mule Wash	Pete's Wash
	Ephemeral	Ephemeral	Ephemeral	Ephemeral	Ephemeral
	Ehrenberg Wash (PR)	Gould Wash (PR)	Mohave Wash (PR)	Mule Wash (PR)	Pete's Wash (PR)
	300-350/50 est./	300-350/50 est./	300-350/50 est./	200-250/50 est./	200-250/50 est./
	100	75	50	50	50
	Sand, gravel	Sand, gravel	Sand, gravel	Sand, gravel	Sand, gravel
	Primary drainages, 1 to 3 nm; Secondary drainages, 100 to 200 feet				
		CF1	CF1	CF1	
of					

Observations are based mainly on a brief aerial reconnaissance and interpretation of topographic maps and aerial photographs.

	Pete's Wash	Trigo Wash	Weaver Wash	Numerous unnamed streams
	Ephemeral	Ephemeral	Ephemeral	Ephemeral
R)	Pete's Wash (PR)	Trigo Wash (PR)	Weaver Wash (PR)	Numerous unnamed washes (S)
st./	200-250/50 est./	300-350/50 est./	300-350/50 est./	
	50	60	75	50 to 75
	Sand, gravel	Sand, gravel	Sand, gravel	Sand, gravel
		CF1		

QUALITY OF DATA	DESCRIPTION			
	A. DEPTH TO GROUNDWATER WITHIN BASIN-FILL MATERIAL IN SITING VALLEY (Map area in nm^2)			
◒	1. 0 to 50 feet	1	1%	
◒	a. 0 to 25 feet	0	0	
◒	b. 25 to 50 feet	1	1%	
◒	2. 50 to 100 feet	12	16%	
○	3. Greater than 100 feet			
◒	4. Unknown or not Present	65	83%	Unknown,
	B. AQUIFER CHARACTERISTICS IN VALLEY			
○	1. Type of Aquifer (B=Basin Fill; P=Perched; R=Rock; u=unconfined; c=confined)			
○	a. Map area and extent			
○	b. Depth to aquifer (ft.)			
○	c. Thickness (ft.)			
○	d. Composition			
○	e. Porosity (%)			
○	f. Specific yield (%)			
○	g. Transmissivity ($ft.^2$/day)			
○	h. Specific capacity (gpm/ft. of drawdown)			
○	i. Total pumpage (ac. ft./unit time)			
○	j. Groundwater ownership rights			
	C. WATER BUDGET FOR VALLEY			
○	1. Total Recharge (ac. ft./unit time)			
○	2. Total Discharge (ac. ft./unit time)			
	D. ADDITIONAL REMARKS			

Quality of Data

- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

I O N			
BASIN-FILL p area 1	1	1%	
	0	0	
	1	1%	
	12	16%	
	65	83%	Unknown, but probably greater than 100 feet, if present
ALLEY Fill; P=Perched; confined)			
. of drawdown)			
it time)			
ts			
unit time)			
/unit time)			

QUALITY OF DATA	DESCRIPTION		
	A. DEPTH TO GROUNDWATER WITHIN BASIN-FILL MATERIAL IN SITING VALLEY (Map area in nm^2)		
◒	1. 0 to 50 feet	1	1%
◒	a. 0 to 25 feet	0	0
◒	b. 25 to 50 feet	1	1%
◒	2. 50 to 100 feet	12	16%
O	3. Greater than 100 feet		
◒	4. Unknown or not Present	65	83%
	B. AQUIFER CHARACTERISTICS IN VALLEY		
O	1. Type of Aquifer (B=Basin Fill; P=Perched; R=Rock; u=unconfined; c=confined)		
O	a. Map area and extent		
O	b. Depth to aquifer (ft.)		
O	c. Thickness (ft.)		
O	d. Composition		
O	e. Porosity (%)		
O	f. Specific yield (%)		
O	g. Transmissivity ($ft.^2$/day)		
O	h. Specific capacity (gpm/ft. of drawdown)		
O	i. Total pumpage (ac. ft./unit time)		
O	j. Groundwater ownership rights		
	C. WATER BUDGET FOR VALLEY		
O	1. Total Recharge (ac. ft./unit time)		
O	2. Total Discharge (ac. ft./unit time)		
	D. ADDITIONAL REMARKS		

Quality of Data
- ● Data derived from detailed studies
- ◒ Estimated values
- O Insufficient data available

I O N			
ASIN-FILL p area			
	1	1%	
	0	0	
	1	1%	
	12	16%	
	65	83%	Unknown, but probably greater than 100 feet, if present
ALLEY Fill; P=Perched; confined)			
)			
. of drawdown)			
it time)			
hts			
/unit time)			
./unit time)			

QUALITY OF DATA	DESCRIPTION			
	A. VALLEY AREA, OWNERSHIP AND LAND UTILIZATION			
●	1. Area of Valley	$324nm^2$	100%	
●	a. Area of valley excluded by major cultural or quantity-distance exclusions and 10% grade exclusion	$255nm^2$	79%	Approxi
●	2. Area of Siting Valley (A.1 minus A.1.a)	$69nm^2$	21%	
●	3. Ownership	DoD, U.S. Army, Yuma Pro		
●	a. Portion of siting valley with direct DoD ownership	$69nm^2$	100%	
●	b. Co-owners or administrators of co-use land/ constraints	Small tracts (sections) for state or private use		
◒	4. Contiguous BLM or Co-Use Land (area in nm^2)	<10	BLM (Castle Dom	
◒	a. Relative location in or adjacent to valley	Adjacent to Valley east		
○	b. Present use			
	B. CULTURAL AND QUANTITY-DISTANCE EXCLUSIONS			
●	1. Location of 18 nm Arc (population greater than 25,000)	Southern portion of Vall		
●	2. Location of 3 nm Arc (population greater than 5,000)	None		
●	3. Other	1780 foot exclusion corr		
	C. CULTURAL IMPROVEMENTS			
●	1. Roads/Railroads (name)	U.S. 95		
●	a. Relative location in valley	Trends north-south, tran and southeast corner of		
●	b. Type and use	Improved; public highwa		
●	2. Utilities (type)	Natural gas and oil pipe		
●	a. Relative location in valley	Parallel and adjacent to also in YPG Headquarters		
●	D. MILITARY/GOVERNMENTAL USE AREAS	Cibola Range		
●	1. Location and areal extent (nm^2)	Northern non-rock portio Mountains; approximately		
●	2. Present use	Aircraft armament tests		
○	3. Future use			
●	4. Decontamination necessary prior to siting	Contaminated with 2.75		
	E. ADDITIONAL REMARKS			

Quality of Data
- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

D N			
ATION	$324nm^2$	100%	
ural 10%	$255nm^2$	79%	Approximately $1.5nm^2$ under transfer to BLM, along western boundary
.1.a)	$69nm^2$	21%	
	DoD, U.S. Army, Yuma Proving Grounds		
DoD	$69nm^2$	100%	
land/	Small tracts (sections) periodically leased for short term (10 years) for state or private use (approximately 2%)		
	<10	BLM (Castle Dome Plain)	
valley	Adjacent to Valley east of YPG boundary, restricted by Kofa Game Range		
ONS greater	Southern portion of Valley from Yuma, Arizona		
reater	None		
	1780 foot exclusion corridor along U.S. 95		
	U.S. 95	Unnamed roads and jeep trails	
	Trends north-south, transects northeast and southeast corner of Valley	Randomly transect Valley	
	Improved; public highway	Improved and unimproved; military and restricted civilian	
	Natural gas and oil pipelines, electrical transmission lines and telephone system		
	Parallel and adjacent to U.S. 95; electrical transmission lines and telephone system also in YPG Headquarters area in southern portion of Valley extending from U.S. 95		
	Cibola Range Northern non-rock portion of Valley bounded by Chocolate and Middle Mountains; approximately 30 nm^2		
	Aircraft armament tests and air-to-ground missile firing		
siting	Contaminated with 2.75 rocket, 20 and 40 mm shells and flechette increments		

QUALITY OF DATA	DESCRIPTION		
	A. TOPOGRAPHIC GRADIENT IN SITING VALLEY		
●	1. Area with Less than 10% Grade	$69nm^2$	100%
●	2. Area with 5 to 10% Grade	$2nm^2$	3%
●	3. Area with 0 to 5% Grade	$67nm^2$	97%
●	4. Location of Alluvial Passes or Valley Boundaries Having Less than 10% Grade	East central porti by Los Angeles and	
	B. ROCK CONDITIONS IN SITING VALLEY (BR=Basement, B=Bedrock, VF=Volcanic Flows)		
●	1. Exposed Rock (category/symbol/lithology)	None	
	a. Location and map area in nm^2	0	0
	b. Seismic velocity (p/s in fps)	N/A	
	c. Conditions of volcanic flow	N/A	
◐	2. Pediments (rock type)	None	
	a. Location and map area in nm^2	0	0
	b. Exposure condition	N/A	
	c. Distance into siting valley from rock exposures (max./min./avg.) (nm)	N/A	
	C. SUBSURFACE ROCK CONDITIONS IN SITING VALLEY (BR=Basement, B=Bedrock, VF=Volcanic Flows)		
	1. Depth to Rock (map area in nm^2)		
●	a. 0 to 250 feet (excluding pediments)	65	94%
◐	1) Type	BR, B	
○	2) Seismic velocity (p/s in fps)		
●	b. 250 to 500 feet	4	6%
◐	1) Type	BR, B	
○	2) Seismic velocity (p/s in fps)		
●	c. 500 to 1000 feet	0	0
	1) Type	N/A	
	2) Seismic velocity (p/s in fps)	N/A	
●	d. Greater than 1000 feet	0	0
	1) Type	N/A	
	2) Seismic velocity (p/s in fps)	N/A	
●	e. Unknown	0	0

Quality of Data

● Data derived from detailed studies

◐ Estimated values

○ Insufficient data available

CRIPTION			
SITING VALLEY 10% Grade	$69nm^2$	100%	
Grade	$2nm^2$	3%	
rade	$67nm^2$	97%	
l Passes or Valley ess than 10% Grade	East central portion of Valley connects with Castle Dome Plain by Los Angeles and Indian Washes.		
LLEY , VF=Volcanic Flows) ory/symbol/lithology)	None		
ea in nm^2	0	0	N/A
/s in fps)	N/A		
nic flow	N/A		
)	None		
ea in nm^2	0	0	N/A
	N/A		
g valley from rock ./avg.) (nm)	N/A		
ONS IN SITING VALLEY , VF=Volcanic Flows) area in nm^2)			
uding pediments)	65	94%	
	BR, B		
ty (p/s in fps)			
	4	6%	
	BR, B		
ty (p/s in fps)			
	0	0	
	N/A		
ty (p/s in fps)	N/A		
feet	0	0	
	N/A		
ty (p/s in fps)	N/A		
	0	0	

s

QUALITY OF DATA	DESCRIPTION		
○	2. Rock (Section 2.2.3) in Basin-Fill Deposits (map area in nm^2)		
○	a. Type		
○	b. Depth to (ft.)		
○	c. Thickness (ft.)		
○	d. Seismic velocity (p/s in fps)		
	D. BASIN-FILL DEPOSITS IN SITING VALLEY		
●	1. Undifferentiated Deposits (A; map area in nm^2)	0	0
	a. Thickness (max./min./avg. in ft.)	N/A	
	b. Lithology	N/A	
	c. Seismic velocity (p/s in fps)	N/A	
●	2. Alluvial Fan Deposits (A_5; map area in nm^2)	50	72%
○	a. Thickness (max./min./avg. in ft.)		
◐	b. Lithology	Sand, silt, g	
○	c. Seismic velocity (p/s in fps)		
●	3. Playa Deposits (A_4; map area in nm^2)	0	0
	a. Thickness (max./min./avg. in ft.)	N/A	
	b. Lithology	N/A	
	c. Seismic velocity (p/s in fps)	N/A	
●	4. Wind-blown Sand (A_3; map area in nm^2)	0	0
	a. Thickness (max./min./avg. in ft.)	N/A	
	b. Lithology	N/A	
	c. Seismic velocity (p/s in fps)	N/A	
●	5. Pediment Deposits (A_6; map area in nm^2)	0	0
	a. Thickness (max./min./avg. in ft.)	N/A	
	b. Lithology	N/A	
	c. Seismic velocity (p/s in fps)	N/A	
●	6. Stream Channel and Floodplain Deposits (A_1; map area in nm^2)	19	28%
○	a. Thickness (max./min./avg. in ft.)		
◐	b. Lithology	Sand, silt,	
○	c. Seismic velocity (p/s in fps)		

Quality of Data

● Data derived from detailed studies

◐ Estimated values

○ Insufficient data available

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D E S C R I P T I O N			
2.2.3) in Basin-Fill Deposits m2)			
.)			
t.)			
city (p/s in fps)			
TS IN SITING VALLEY ted Deposits (A; map area	0	0	
ax./min./avg. in ft.)	N/A		
	N/A		
city (p/s in fps)	N/A		
Deposits (A_5; map area in nm2)	50	72%	
ax./min./avg. in ft.)			
	Sand, silt, gravel		
city (p/s in fps)			
s (A_4; map area in nm2)	0	0	
ax./min./avg. in ft.)	N/A		
	N/A		
city (p/s in fps)	N/A		
nd (A_3; map area in nm2)	0	0	
ax./min./avg. in ft.)	N/A		
	N/A		
city (p/s in fps)	N/A		
sits (A_6; map area in nm2)	0	0	
ax./min./avg. in ft.)	N/A		
	N/A		
city (p/s in fps)	N/A		
l and Floodplain Deposits in nm2)	19	28%	
ax./min./avg. in ft.)			
	Sand, silt, gravel		
locity (p/s in fps)			

studies

QUALITY OF DATA	DESCRIPTION	
●	7. Terrace Deposits (A_2; map area in nm^2)	0
○	a. Thickness (max./min./avg. in ft.)	N/A
○	b. Lithology	N/A
○	c. Seismic velocity (p/s in fps)	N/A
○	8. General Summary of Relationships	
	E. TECTONIC FRAMEWORK OF SITING VALLEY	
●	1. Capable or Potentially Capable Fault	None
	a. Total length (nm)	N/A
	b. Relative location	N/A
	c. Type of faulting, regional and local attitudes (strike and dip)	N/A
	d. Minimum age of displacement or seismic activity (y.b.p.)	N/A
●	2. Volcanism	None
	a. Volcanic flows	N/A
	1) Location and map area in nm^2	N/A
	2) Minimum age of volcanic activity (y.b.p.)	N/A
	F. SEISMICITY OF SITING VALLEY (Regional seismicity discussed in Section 2.2.4 of text)	
●	1. Relative Pre-Instrumental Historic Activity (Section 2.2.4)	None
◒	2. Site Area Seismic Activity (instrumental, 1927-1973; Section 2.2.4)	
◒	a. Events (epicenters) greater than M=6.0	None
◒	b. Events (epicenters) greater than M=1.0 and less than M=6.0	None
○	c. Events less than M=1.0 (includes microearthquakes)	
◒	3. Maximum Reported Modified Mercalli Intensity	VI to VII
◒	4. Source of Possible Ground Acceleration Levels (Section 2.2.4)	Salton Tr
◒	a. Maximum credible level (g)	0.25
◒	b. Most probable level (g)	
	G. Additional Remarks	

Quality of Data
- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

352-B

N			
m2)	0	0	
	N/A		
	N/A		
	N/A		
lt	None		
	N/A		
	N/A		
attitudes	N/A		
c activity	N/A		
	None		
	N/A		
	N/A		
	N/A		
seismicity Activity	None		
mental,			
.0	None		
.0 and less	None		
roearthquakes)			
Intensity	VI to VII(?)		
tion Levels	Salton Trough (Zone 1)	Transition Zone (Zone 2)	Diffuse Seismicity (Zone 3)
	0.25	0.05	0.2
		0.05	

SOILS ENGINEERING PROPERTIES (1)	MAP UNIT NU[MBER] 27	28
Unified soil classification (2)	GM-SM	GM, SM, ML,
AASHO soil classification	A-1, A-2	A-1, A-2,
Percent passing #4 sieve	35-80	40-95
Percent passing #40 sieve	30-55	40-65
Percent passing #200 sieve	15-35	25-50
Liquid limit/plasticity index	NP/NP	20-30/0-10
Surface consistency		
Dry density (pcf)		
Permeability (cm/sec)	10^{-2} to 10^{-4}	10^{-1} to 10
In-situ shear strength (psi)		
In-situ angle of internal friction (degrees)		
Cohesion (psi)		
Shrink-swell potential	Low	Low
Coefficient of compressibility (in^2/lb.)		
In-situ CBR		
Recompacted CBR		
General surface moisture condition		
Compressional wave velocities (fps)		
Shear wave velocities (fps)		
Deleterious substances	Caliche present in some areas	Sulfates p[resent] in some ar[eas]
ENGINEERING DESIGN EVALUATIONS (1)		
Suitability as impermeable membrane when recompacted	Poor	Poor
Suitability as source of sand/fill material	Fair/Good	Poor/Fair
Suitability as source of aggregate/base course	Fair/Fair	Fair/Fair
Near surface foundation design characteristics	Mod. strength Low comp.	Mod. stren[gth]
Excavation limitations and slope angle	Sloughing and/or difficult ripping	Sloughing 45°-60°
Additional Remarks	Highly alkaline; corrosive to uncoated steel; ($A5_{QT}$; $A5c_Q$)	Highly alk[aline]; corrosive uncoated s[teel]; possible s[ulfate] corrosion concrete; ($A5_Q$)

Explanation

(blank box)	No literature available and data not extrapolated
(SP-SM)	No literature available and data extrapolated
SP-SM	Data available in literature

(1) Surface soils only, depth of less than 5 feet

(2) Related geologic unit(s) shown in Additional Remarks (e.g. Al_Q)

...EERING PROPERTIES (1)	MAP UNIT NUMBER 27	28	33
...classification (2)	GM-SM	GM, SM, ML	CM,SM,SP,ML,CL
...assification	A-1, A-2	A-1, A-2, or A-4	A-2,A-4,A-6 or A-7
...ng #4 sieve	35-80	40-95	45-100
...ng #40 sieve	30-55	40-65	50-100
...ng #200 sieve	15-35	25-50	50-100
.../plasticity index	NP/NP	20-30/0-10	10-45/NP-30
...stency			
...pcf)			
... (cm/sec)	10^{-2} to 10^{-4}	10^{-1} to 10^{-3}	10^{-2} to 10^{-4}
... strength (psi)			
... of internal friction (degrees)			
...)			
... potential	Low	Low	Low to moderate
...of compressibility (in^2/lb.)			
...CBR			
...ce moisture condition			
... wave velocities (fps)			
...locities (fps)			
...ubstances	Caliche present in some areas	Sulfates present in some areas	
... DESIGN EVALUATIONS (1)			
...s impermeable membrane when recompacted	Poor	Poor	Fair to Poor
...s source of sand/fill material	Fair/Good	Poor/Fair	Fair/Fair
...s source of aggregate/base course	Fair/Fair	Fair/Fair	Fair/Fair
... foundation design characteristics	Mod. strength Low comp.	Mod. strength	Low strength Mod. comp.
...mitations and slope angle	Sloughing and/or difficult ripping	Sloughing 45°-60°	45°-60°
Additional Remarks	Highly alkaline; corrosive to uncoated steel; ($A5_{QT}$; $A5c_Q$)	Highly alkaline; corrosive to uncoated steel; possible sulfate corrosion of concrete; ($A5_Q$)	Subject to flooding; (Al_Q)

... literature available and data not extrapolated
... literature available and data extrapolated
...ta available in literature
...) Surface soils only, depth of less than 5 feet
...) Related geologic unit(s) shown in Additional Remarks (e.g. Al_Q)

QUALITY OF DATA	DESCRIPTION	
	A. SURFACE WATER IN SITING VALLEY	
●	1. Playas; Intermittent and Perennial Lakes	None
	a. Duration of surface water (wks.)	N/A
	b. Maximum extent (nm^2)	N/A
	c. Water depth (avg. in ft.)	N/A
	d. Source of water	N/A
	e. Water quality	N/A
◒	2. Springs	None
	a. Duration of flow (wks.)	N/A
	b. Estimated maximum flow rate (gpm/season)	N/A
	c. Water quality	N/A
◒	3. Rivers or Streams	Indian Wash
◒	a. Rate (gpm) and duration of flow (wks.)	Ephemeral
○	b. Water quality	
	B. HYDROLOGIC CHARACTERISTICS OF SITING VALLEY	
◒	1. Drainage Channel (PR=Primary; S=Secondary)	Indian Wash (PR)
○	a. Depth of incision (max./min./avg.; ft.)	
◒	b. Width (max./min./avg.; ft.)	3000/50/
◒	c. Gradient (ft./mi.)	50
◒	d. Channel bottom characteristics	Gravel, sand, cobbles
◒	e. Channel cross-section (schematic)	
◒	f. Channel spacing (avg. in ft.)	Primary drainages, 1
◒	g. Preliminary flood susceptibility rating (Section 2.4.1)	CF1
○	2. Preliminary Flood Susceptibility Rating of Major Landform Surfaces (Section 2.4.1)	
○	a. Undifferentiated deposits	
○	b. Alluvial fans	
○	c. Playas (active=a; mantled=m)	
○	d. Pediments	
○	e. Sand dunes	
○	f. Terraces (l=lake; r=river)	
	C. ADDITIONAL REMARKS	Observations are base interpretation of top

Quality of Data

● Data derived from detailed studies

◒ Estimated values

○ Insufficient data available

None
N/A
N/A
N/A
N/A
N/A
None
N/A
N/A
N/A

Indian Wash	Los Angeles Wash	McCallister Wash	Yuma Wash	Numerous u
Ephemeral	Ephemeral	Ephemeral	Ephemeral	Ephemeral
Indian Wash (PR)	Los Angeles Wash (PR)	McCallister Wash (PR)	Yuma Wash (PR)	Numerous u
				/ / 3
3000/50/	1500/50/	3000/50/	1500/50/	
50	50	50	60	50 to 75
Gravel, sand, cobbles	Gravel, sand	Gravel, sand, cobbles	Gravel, sand	Gravel, sa
Primary drainages, 1 to 3 nm; Secondary drainages, 100 to 200 feet				
CF1	CF1	CF1	CF1	

Observations are based mainly on a brief field reconnaissance and interpretation of topographic maps and aerial photographs.

s Angeles Wash	McCallister Wash	Yuma Wash	Numerous unnamed streams
hemeral	Ephemeral	Ephemeral	Ephemeral
s Angeles Wash (PR)	McCallister Wash (PR)	Yuma Wash (PR)	Numerous unnamed washes (S)
			/ / 3 to 5
00/50/	3000/50/	1500/50/	
	50	60	50 to 75
avel, sand	Gravel, sand, cobbles	Gravel, sand	Gravel, sand
; Secondary drainages, 100 to 200 feet			
l	CFl	CFl	

on a brief field reconnaissance and
maps and aerial photographs.

2 3

QUALITY OF DATA	DESCRIPTION			
	A. DEPTH TO GROUNDWATER WITHIN BASIN-FILL MATERIAL IN SITING VALLEY (Map area in nm^2)			
◒	1. 0 to 50 feet	0	0	
◒	a. 0 to 25 feet	0	0	
◒	b. 25 to 50 feet	0	0	
◒	2. 50 to 100 feet	3	4%	
◒	3. Greater than 100 feet	17	25%	100
◒	4. Unknown or not Present	49	71%	Unk
	B. AQUIFER CHARACTERISTICS IN VALLEY			
◒	1. Type of Aquifer (B=Basin Fill; P=Perched; R=Rock; u=unconfined; c=confined)	Bu		
○	a. Map area and extent			
○	b. Depth to aquifer (ft.)			
○	c. Thickness (ft.)			
●	d. Composition	Sand and gravel		
○	e. Porosity (%)			
○	f. Specific yield (%)			
○	g. Transmissivity (ft.^{2}/day)			
○	h. Specific capacity (gpm/ft. of drawdown)			
○	i. Total pumpage (ac. ft./unit time)			
●	j. Groundwater ownership rights	YPG		
	C. WATER BUDGET FOR VALLEY			
○	1. Total Recharge (ac. ft./unit time)			
○	2. Total Discharge (ac. ft./unit time)			
	D. ADDITIONAL REMARKS			

Quality of Data

- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

-FILL			
	0	0	
	0	0	
	0	0	
	3	4%	
	17	25%	100 to 200 feet
	49	71%	Unknown, but probably greater than 200 feet, if present
; P=Perched; ned)	Bu		
	Sand and gravel		
rawdown)			
e)			
	YPG		
time)			
time)			

QUALITY OF DATA	DESCRIPTION			
	A. VALLEY AREA, OWNERSHIP AND LAND UTILIZATION			
●	1. Area of Valley	$321nm^2$	100%	
●	a. Area of valley excluded by major cultural or quantity-distance exclusions and 10% grade exclusion	$164nm^2$	51%	Approxi
●	2. Area of Siting Valley (A.1 minus A.1.a)	$157nm^2$	49%	
●	3. Ownership	DoD, U.S. Army, Yuma Pro		
●	a. Portion of siting valley with direct DoD ownership	$157nm^2$	100%	
●	b. Co-owners or administrators of co-use land/ constraints	Small tracts (sections) for state or private use		
◐	4. Contiguous BLM or Co-Use Land (area in nm^2)	20-25	BLM (Castle Dom	
◐	a. Relative location in or adjacent to valley	Adjacent to Valley north Range; adjacent to Valle		
○	b. Present use			
	B. CULTURAL AND QUANTITY-DISTANCE EXCLUSIONS			
●	1. Location of 18 nm Arc (population greater than 25,000)	Southwestern portion of V		
●	2. Location of 3 nm Arc (population greater than 5,000)	None		
●	3. Other	1780 foot exclusion corri		
	C. CULTURAL IMPROVEMENTS			
●	1. Roads/Railroads (name)	U.S. 95		
●	a. Relative location in valley	Parallel and adjacent to western boundary		
●	b. Type and use	Improved; public highway		
●	2. Utilities (type)	Natural gas and oil pipel		
●	a. Relative location in valley	Parallel and adjacent to lines also along south Po		
●	D. MILITARY/GOVERNMENTAL USE AREAS			
●	1. Location and areal extent (nm^2)	Approximately northern tw		
●	2. Present use	Munitions and weapons tes		
○	3. Future use			
●	4. Decontamination necessary prior to siting	Contaminated with 60 mm, 175 mm and 8-inch shells		
	E. ADDITIONAL REMARKS			

Quality of Data

- ● Data derived from detailed studies
- ◐ Estimated values
- ○ Insufficient data available

N			
TION	$321nm^2$	100%	
ral	$164nm^2$	51%	Approximately $40nm^2$ under transfer to BLM (Muggins Mtns.)
1.a)	$157nm^2$	49%	
	DoD, U.S. Army, Yuma Proving Grounds		
oD	$157nm^2$	100%	
land/	Small tracts (sections) periodically leased for short term (10 years) for state or private use (approximately 2%)		
	20-25	BLM (Castle Dome Plain; north and Mohawk Valley;south)	
lley	Adjacent to Valley northwest of YPG boundary ($10-12nm^2$) limited by Kofa Game Range; adjacent to Valley southeast of YPG boundary ($10-12nm^2$)		
NS			
reater	Southwestern portion of Valley from Yuma, Arizona		
eater	None		
	1780 foot exclusion corridor along U.S. 95		
	U.S. 95	Roads (Firing Front, South Pole-line and North Boundary) and jeep trails	
	Parallel and adjacent to western boundary	Parallel Valley boundaries and randomly transect Valley	
	Improved; public highway	Improved and unimproved dirt roads; military and restricted civilian	
	Natural gas and oil pipelines, electrical transmission lines and telephone lines		
	Parallel and adjacent to U.S. 95; electrical transmission lines and telephone lines also along south Pole-line road and north boundary road		
	Approximately northern two-thirds of Valley; approximately $250nm^2$		
	Munitions and weapons testing and ammunition storage		
siting	Contaminated with 60 mm, 81 mm, and 4.2-inch mortar, 2.75 rocket, 105 mm, 155 mm, 175 mm and 8-inch shells and flechette increments		

QUALITY OF DATA	DESCRIPTION		
	A. TOPOGRAPHIC GRADIENT IN SITING VALLEY		
●	1. Area with Less than 10% Grade	157nm^2	100%
●	2. Area with 5 to 10% Grade	2nm^2	1%
●	3. Area with 0 to 5% Grade	155nm^2	99%
●	4. Location of Alluvial Passes or Valley Boundaries Having Less than 10% Grade	Western portion o Ang-.es and India King Valley acros	
	B. ROCK CONDITIONS IN SITING VALLEY (BR=Basement, B=Bedrock, VF=Volcanic Flows)		
●	1. Exposed Rock (category/symbol/lithology)	BR/Il$_{MP}$, M$_{MP}$/gnei	
◒	a. Location and map area in nm^2	1	1%
○	b. Seismic velocity (p/s in fps)		
	c. Conditions of volcanic flow	N/A	
◒	2. Pediments (rock type)	None	
	a. Location and map area in nm^2	0	0
	b. Exposure condition	N/A	
	c. Distance into siting valley from rock exposures (max./min./avg.) (nm)	N/A	
	C. SUBSURFACE ROCK CONDITIONS IN SITING VALLEY (BR=Basement, B=Bedrock, VF=Volcanic Flows)		
	1. Depth to Rock (map area in nm^2)		
◒	a. 0 to 250 feet (excluding pediments)	15	10%
◒	1) Type	BR, B	
○	2) Seismic velocity (p/s in fps)		
◒	b. 250 to 500 feet		
◒	1) Type	BR, B	
○	2) Seismic velocity (p/s in fps)		
◒	c. 500 to 1000 feet		
◒	1) Type	BR, B	
○	2) Seismic velocity (p/s in fps)		
◒	d. Greater than 1000 feet	0	0
	1) Type	N/A	
	2) Seismic velocity (p/s in fps)	N/A	
◒	e. Unknown	141	89%

Quality of Data

● Data derived from detailed studies

◒ Estimated values

○ Insufficient data available

N			
	157nm^2	100%	
	2nm^2	1%	
	155nm^2	99%	
lley / rade	Western portion of Valley connects with Indian Wash Valley by Los Angeles and Indian Washes. Northern and eastern contiguous with King Valley across Valley boundary.		
lows)			
ology)	BR/Il$_{MP}$, M$_{MP}$/gneiss, schist, granitics		
	1	1%	Along flanks of Muggins and Castle Dome Mountains and randomly distributed mainly in eastern one-half of Valley,
	N/A		
	None		
	0	0	N/A
	N/A		
k	N/A		
VALLEY lows)			
	15	10%	
	BR, B		
			See Additional Remarks (a)
	BR, B		
			See Additional Remarks (a)
	BR, B		
	0	0	
	N/A		
	N/A		
	141	89%	Greater than 250 feet, data insufficient for contouring

AD-A113 214 FUGRO NATIONAL INC LONG BEACH CA F/G 8/6
MX SITING INVESTIGATION. VOLUME IIB. GEOTECHNICAL REPORT, YUMA --ETC(U)
JUN 75 F04701-74-C-0013
UNCLASSIFIED FN-TR-3-VOL-2B NL

3 of 6
AD A113214

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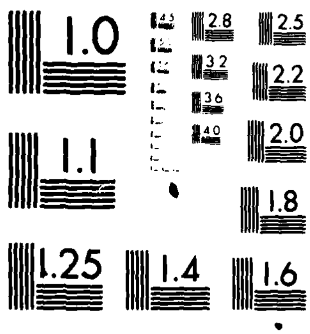


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

QUALITY OF DATA	DESCRIPTION	
○	2. Rock (Section 2.2.3) in Basin-Fill Deposits (map area in nm^2)	
○	a. Type	
○	b. Depth to (ft.)	
○	c. Thickness (ft.)	
○	d. Seismic velocity (p/s in fps)	
	D. BASIN-FILL DEPOSITS IN SITING VALLEY	
●	1. Undifferentiated Deposits (A; map area in nm^2)	0
	a. Thickness (max./min./avg. in ft.)	N/A
	b. Lithology	N/A
	c. Seismic velocity (p/s in fps)	N/A
●	2. Alluvial Fan Deposits (A_5; map area in nm^2)	147
○	a. Thickness (max./min./avg. in ft.)	
◐	b. Lithology	Sand, sil
○	c. Seismic velocity (p/s in fps)	
●	3. Playa Deposits (A_4; map area in nm^2)	0
	a. Thickness (max./min./avg. in ft.)	N/A
	b. Lithology	N/A
	c. Seismic velocity (p/s in fps)	N/A
●	4. Wind-blown Sand (A_3; map area in nm^2)	0
	a. Thickness (max./min./avg. in ft.)	N/A
	b. Lithology	N/A
	c. Seismic velocity (p/s in fps)	N/A
●	5. Pediment Deposits (A_6; map area in nm^2)	0
	a. Thickness (max./min./avg. in ft.)	N/A
	b. Lithology	N/A
	c. Seismic velocity (p/s in fps)	N/A
●	6. Stream Channel and Floodplain Deposits (A_1; map area in nm^2)	9
○	a. Thickness (max./min./avg. in ft.)	
◐	b. Lithology	Sand, sil
○	c. Seismic velocity (p/s in fps)	

Quality of Data

● Data derived from detailed studies

◐ Estimated values

○ Insufficient data available

362-A

DESCRIPTION			
on 2.2.3) in Basin-Fill Deposits n nm^2)			
(ft.)			
(ft.)			
locity (p/s in fps)			
SITS IN SITING VALLEY iated Deposits (A; map area	0	0	
(max./min./avg. in ft.)	N/A		
	N/A		
elocity (p/s in fps)	N/A		
n Deposits (A_5; map area in nm^2)	147	93%	
(max./min./avg. in ft.)			
y	Sand, silt, gravel; includes fanglomerate		
elocity (p/s in fps)			
its (A_4; map area in nm^2)	0	0	
(max./min./avg. in ft.)	N/A		
y	N/A		
elocity (p/s in fps)	N/A		
Sand (A_3; map area in nm^2)	0	0	
(max./min./avg. in ft.)	N/A		
y	N/A		
velocity (p/s in fps)	N/A		
eposits (A_6; map area in nm^2)	0	0	
(max./min./avg. in ft.)	N/A		
y	N/A		
velocity (p/s in fps)	N/A		
nnel and Floodplain Deposits rea in nm^2)	9	6%	
(max./min./avg. in ft.)			
y	Sand, silt, gravel		
velocity (p/s in fps)			

led studies

able

QUALITY OF DATA	DESCRIPTION		
●	7. Terrace Deposits (A_2; map area in nm^2)	0	0
	a. Thickness (max./min./avg. in ft.)	N/A	
	b. Lithology	N/A	
	c. Seismic velocity (p/s in fps)	N/A	
○	8. General Summary of Relationships		
	E. TECTONIC FRAMEWORK OF SITING VALLEY		
●	1. Capable or Potentially Capable Fault	None	
	a. Total length (nm)	N/A	
	b. Relative location	N/A	
	c. Type of faulting, regional and local attitudes (strike and dip)	N/A	
	d. Minimum age of displacement or seismic activity (y.b.p.)	N/A	
●	2. Volcanism	None	
	a. Volcanic flows	N/A	
	1) Location and map area in nm^2	N/A	
	2) Minimum age of volcanic activity (y.b.p.)	N/A	
	F. SEISMICITY OF SITING VALLEY (Regional seismicity discussed in Section 2.2.4 of text)		
◒	1. Relative Pre-Instrumental Historic Activity (Section 2.2.4)	None	
◒	2. Site Area Seismic Activity (instrumental, 1927-1973; Section 2.2.4)		
◒	a. Events (epicenters) greater than M=6.0	None	
◒	b. Events (epicenters) greater than M=1.0 and less than M=6.0	None	
○	c. Events less than M=1.0 (includes microearthq		
◒	3. Maximum Reported Modified Mercalli Intensity	VI to VII (?)	
◒	4. Source of Possible Ground Acceleration Levels (Section 2.2.4)	Salton Trougl	
◒	a. Maximum credible level (g)	0.3	
◒	b. Most probable level (g)		
	G. Additional Remarks	(a) Well # 1: data ins	

Quality of Data
- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

362-8

O N			
n nm2)	0	0	
	N/A		
	N/A		
	N/A		
s			
Fault	None		
	N/A		
	N/A		
cal attitudes	N/A		
ismic activity	N/A		
	None		
	N/A		
	N/A		
ity	N/A		
al seismicity ric Activity	None		
trumental,			
M=6.0	None		
M=1.0 and less	None		
microearthquakes)			
lli Intensity	VI to VII (?)		
eration Levels	Salton Trough (Zone 1)	Transition Zone (Zone 2)	Diffuse Seismicity (Zone 3)
	0.3	0.05	0.2
		0.05	
	(a) Well # 11 indicated depth to basement rock of 705 feet; data insufficient for contouring.		

SOILS ENGINEERING PROPERTIES(1)	26	27
Unified soil classification(2)	(GM-SM)	GM-SM
AASHO soil classification	(A-1, A-2)	A-1, A-2
Percent passing #4 sieve		35-80
Percent passing #40 sieve		30-55
Percent passing #200 sieve		15-35
Liquid limit/plasticity index		NP/NP
Surface consistency		
Dry density (pcf)		
Permeability (cm/sec)		10^{-2} to 10^{-4}
In-situ shear strength (psi)		
In-situ angle of internal friction (degrees)		
Cohesion (psi)		
Shrink-swell potential		Low
Coefficient of compressibility (in^2/lb.)		
In-situ CBR		
Recompacted CBR		
General surface moisture condition		
Compressional wave velocities (fps)		
Shear wave velocities (fps)		
Deleterious substances	Caliche present	Caliche present in some areas
ENGINEERING DESIGN EVALUATIONS(1)		
Suitability as impermeable membrane when recompacted	(Poor)	Poor
Suitability as source of sand/fill material	(Fair)/(Fair)	Fair/Good
Suitability as source of aggregate/base course	(Fair)/(Fair)	Fair/Fair
Near surface foundation design characteristics	(High strength)	Mod. strength Low comp.
Excavation limitations and slope angle	(Difficult ripping or blasting)	Sloughing and/ difficult ripp
Additional Remarks	Highly cemented; (A5t)	Highly alkalin corrosive to uncoated steel; ($A5_{QT}$; $A5c_Q$)

Explanation

(empty box)	No literature available and data not extrapolated
(SP-SM)	No literature available and data extrapolated
SP-SM	Data available in literature

(1) Surface soils only, depth of less than 5 feet

(2) Related geologic unit(s) shown in Additional Remarks (e.g. Al_Q)

s(1)	MAP UNIT NUMBER 26	27	28	33
	(GM-SM)	GM-SM	GM,SM,ML	GM,SM,SP,ML,CL
	(A-1, A-2)	A-1, A-2	A-1,A-2 or A-4	A-2,A-4,A-6 or A-7
		35-80	40-95	45-100
		30-55	40-65	30-100
		15-35	25-50	50-100
		NP/NP	20-30/0-10	10-45/NP-30
		10^{-2} to 10^{-4}	10^{-1} to 10^{-3}	10^{-2} to 10^{-4}
on (degrees)				
		Low	Low	Low to moderate
(in^2/lb.)				
on				
ps)				
	Caliche present	Caliche present in some areas	Sulfates present in some areas	
ONS(1)				
rane when recompacted	(Poor)	Poor	Poor	Fair to Poor
ill material	(Fair)/(Fair)	Fair/Good	Poor/Fair	Fair/Fair
te/base course	(Fair)/(Fair)	Fair/Fair	Fair/Fair	Fair/Fair
characteristics	(High strength)	Mod. strength Low comp.	Mod. strength	Low strength Mod. comp.
angle	(Difficult ripping or blasting)	Sloughing and/or difficult ripping	Sloughing 45°-60°	45°-60°
le and data not extrapolated le and data extrapolated erature y, depth of less than 5 feet unit(s) shown in Additional) — Additional Remarks	Highly cemented; (A5t)	Highly alkaline; corrosive to uncoated steel; ($A5_{QT}$; $A5c_Q$)	Highly alkaline; corrosive to uncoated steel; possible sulfate corrosion to concrete; ($A5_Q$)	Subject to flooding; ($A1_Q$)

QUALITY OF DATA	DESCRIPTION	
	A. SURFACE WATER IN SITING VALLEY	
●	1. Playas; Intermittent and Perennial Lakes	None
	a. Duration of surface water (wks.)	N/A
	b. Maximum extent (nm^2)	N/A
	c. Water depth (avg. in ft.)	N/A
	d. Source of water	N/A
	e. Water quality	N/A
◐	2. Springs	None
	a. Duration of flow (wks.)	N/A
	b. Estimated maximum flow rate (gpm/season)	N/A
	c. Water quality	N/A
◐	3. Rivers or Streams	Big Eye Wash
◐	a. Rate (gpm) and duration of flow (wks.)	Ephemeral
○	b. Water quality	
	B. HYDROLOGIC CHARACTERISTICS OF SITING VALLEY	
◐	1. Drainage Channel (PR=Primary; S=Secondary)	Big Eye Wash (P
◐	a. Depth of incision (max./min./avg.; ft.)	/ / 4
◐	b. Width (max./min./avg.; ft.)	1500/100 est./
◐	c. Gradient (ft./mi.)	40
◐	d. Channel bottom characteristics	Gravel, sand, c
◐	e. Channel cross-section (schematic)	
○	f. Channel spacing (avg. in ft.)	
◐	g. Preliminary flood susceptibility rating (Section 2.4.1)	
◐	2. Preliminary Flood Susceptibility Rating of Major Landform Surfaces (Section 2.4.1)	
○	a. Undifferentiated deposits	
◐	b. Alluvial fans	SF1
○	c. Playas (active=a; mantled=m)	
○	d. Pediments	
○	e. Sand dunes	
○	f. Terraces (l=lake; r=river)	
	C. ADDITIONAL REMARKS	Observations ba interpretation

Quality of Data
- ● Data derived from detailed studies
- ◐ Estimated values
- ○ Insufficient data available

l Lakes	None		
	N/A		
	N/A		
	N/A		
	N/A		
	N/A		
	None		
	N/A		
ason)	N/A		
	N/A		
	Big Eye Wash	Castle Dome Wash	Numerous unnamed streams
s.)	Ephemeral	Ephemeral	Ephemeral
VALLEY ndary)	Big Eye Wash (PR)	Castle Dome Wash (PR)	Numerous unnamed washes (PR and S)
ft.)	/ / 4	/ / 4	/ / 3 to 5
	1500/100 est./	1500/25/	
	40	30 to 40	40 to 50
	Gravel, sand, cobbles	Gravel, sand, cobbles	Gravel, sand, cobbles
			
ting		CF1	Unknown to CF1
Rating of 2.4.1)			
	SF1		
	Observations based mainly on a brief field reconnaissance and interpretation of topographic maps and aerial photographs		

QUALITY OF DATA	DESCRIPTION			
	A. DEPTH TO GROUNDWATER WITHIN BASIN-FILL MATERIAL IN SITING VALLEY (Map area in nm^2)			
○	1. 0 to 50 feet			
○	a. 0 to 25 feet			
○	b. 25 to 50 feet			
○	2. 50 to 100 feet			
◒	3. Greater than 100 feet	142	90%	200
◒	4. Unknown or not Present	15	10%	Unk
	B. AQUIFER CHARACTERISTICS IN VALLEY			
●	1. Type of Aquifer (B=Basin Fill; P=Perched; R=Rock; u=unconfined; c=confined)	Bu		
○	a. Map area and extent			
●	b. Depth to aquifer (ft.)	507		
◒	c. Thickness (ft.)	198		
●	d. Composition	Fine gravel and sand		
○	e. Porosity (%)			
○	f. Specific yield (%)			
○	g. Transmissivity ($ft.^2$/day)			
●	h. Specific capacity (gpm/ft. of drawdown)	350 (during pumping t		
○	i. Total pumpage (ac. ft./unit time)			
◒	j. Groundwater ownership rights	YPG		
	C. WATER BUDGET FOR VALLEY			
○	1. Total Recharge (ac. ft./unit time)			
○	2. Total Discharge (ac. ft./unit time)			
	D. ADDITIONAL REMARKS	(a) Rock aquifer is c		

Quality of Data

- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

T I O N			
N BASIN-FILL (Map area			
	142	90%	200 to 500 feet
	15	10%	Unknown, but probably greater than 300 feet, if present

VALLEY		
in Fill; P=Perched; c=confined)	Bu	Rc See Additional Remarks (a)
	507	780
	198	Greater than 220
	Fine gravel and sand	Volcanic tuff ($I2_T$)
ay)		
/ft. of drawdown)	350 (during pumping tests)	
/unit time)		
ights	YPG	YPG

./unit time)	
t./unit time)	
	(a) Rock aquifer is confined bedrock stratum

QUALITY OF DATA	DESCRIPTION			
	A. VALLEY AREA, OWNERSHIP AND LAND UTILIZATION			
●	1. Area of Valley	$184nm^2$	100%	
●	a. Area of valley excluded by major cultural or quantity-distance exclusions and 10% grade exclusion	$50nm^2$	27%	
●	2. Area of Siting Valley (A.1 minus A.1.a)	$134nm^2$	73%	Ap
●	3. Ownership	DoD, U.S. Army, Yuma		
●	a. Portion of siting valley with direct DoD ownership	$134nm^2$	100%	
●	b. Co-owners or administrators of co-use land/ constraints	Small tracts (sectic for state or private		
◒	4. Contiguous BLM or Co-Use Land (area in nm^2)	10	BLM (King V	
◒	a. Relative location in or adjacent to valley	Adjacent to Valley s		
○	b. Present use			
	B. CULTURAL AND QUANTITY-DISTANCE EXCLUSIONS			
●	1. Location of 18 nm Arc (population greater than 25,000)	None		
●	2. Location of 3 nm Arc (population greater than 5,000)	None		
●	3. Other	None		
	C. CULTURAL IMPROVEMENTS			
◒	1. Roads/Railroads (name)	Unnamed roads and je		
◒	a. Relative location in valley	Randomly transect Va		
◒	b. Type and use	Improved and unimprc		
◒	2. Utilities (type)	None		
	a. Relative location in valley	N/A		
●	D. MILITARY/GOVERNMENTAL USE AREAS	Kofa Range		
●	1. Location and areal extent (nm^2)	Entire Valley; 184nm		
●	2. Present use	Munition and weapons		
○	3. Future use			
●	4. Decontamination necessary prior to siting	Contaminated with 2		
	E. ADDITIONAL REMARKS			

Quality of Data

- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

OWNERSHIP AND CULTURAL FEATURES
3.7.1 King Valley (YPG)

$184nm^2$	100%	
$50nm^2$	27%	
$134nm^2$	73%	Approximately $3nm^2$ under transfer to BLM, along southern boundary
DoD, U.S. Army, Yuma Proving Grounds		
$134nm^2$	100%	
Small tracts (sections) periodically leased for short term (10 years) for state or private use (approximately 2-3%)		
10	BLM (King Valley)	
Adjacent to Valley southwest of YPG boundary		
None		
None		
None		
Unnamed roads and jeep trails		
Randomly transect Valley		
Improved and unimproved dirt; military and restricted civilian		
None		
N/A		
Kofa Range		
Entire Valley; $184nm^2$		
Munition and weapons testing; testing of NASA equipment		
Contaminated with 2.75 rocket, 155 mm, 175 mm, and 8-inch shells, and flechette increments		

QUALITY OF DATA	DESCRIPTION			
	A. TOPOGRAPHIC GRADIENT IN SITING VALLEY			
●	1. Area with Less than 10% Grade	$134nm^2$	100%	
●	2. Area with 5 to 10% Grade	$2nm^2$	1%	
●	3. Area with 0 to 5% Grade	$132nm^2$	99%	
●	4. Location of Alluvial Passes or Valley Boundaries Having Less than 10% Grade	Western portion contigu Northern and eastern po		
	B. ROCK CONDITIONS IN SITING VALLEY (BR=Basement, B=Bedrock, VF=Volcanic Flows)			
◒	1. Exposed Rock (category/symbol/lithology)	B/$I2_T$/ andesitic to bas		
◒	a. Location and map area in nm^2	2	1%	Along
○	b. Seismic velocity (p/s in fps)			
	c. Conditions of volcanic flow	N/A		
◒	2. Pediments (rock type)			
◒	a. Location and map area in nm^2	2	1%	Along
◒	b. Exposure condition	Thin mantle of pediment		
○	c. Distance into siting valley from rock exposures (max./min./avg.) (nm)			
	C. SUBSURFACE ROCK CONDITIONS IN SITING VALLEY (BR=Basement, B=Bedrock, VF=Volcanic Flows)			
	1. Depth to Rock (map area in nm^2)			
◒	a. 0 to 250 feet (excluding pediments)	33	25%	
◒	1) Type	BR, B		
○	2) Seismic velocity (p/s in fps)			
◒	b. 250 to 500 feet	27	20%	
◒	1) Type	BR, B		
○	2) Seismic velocity (p/s in fps)			
◒	c. 500 to 1000 feet	25	19%	
◒	1) Type	BR, B		
○	2) Seismic velocity (p/s in fps)			
◒	d. Greater than 1000 feet	45	34%	
◒	1) Type	BR, B		
○	2) Seismic velocity (p/s in fps)			
◒	e. Unknown	0	0	

Quality of Data
- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

	$134nm^2$	100%	
	$2nm^2$	1%	
	$132nm^2$	99%	
	Western portion contiguous with Castle Dome Plain across Valley boundaries Northern and eastern portions contiguous with Palomas Plain across Valley boundaries.		
s) gy)	$B/I2_T/$ andesitic to basaltic volcanics		
	2	1%	Along flanks of Castle Dome, Palomas and Tank Mountains
	N/A		
	2	1%	Along flank of Palomas Mountains
	Thin mantle of pediment deposits		
LEY ws)			
	33	25%	
	BR, B		
	27	20%	
	BR, B		
	25	19%	
	BR, B		
	45	34%	
	BR, B		
	0	0	

QUALITY OF DATA	DESCRIPTION		
○	2. Rock (Section 2.2.3) in Basin-Fill Deposits (map area in nm^2)		
○	a. Type		
○	b. Depth to (ft.)		
○	c. Thickness (ft.)		
○	d. Seismic velocity (p/s in fps)		
	D. BASIN-FILL DEPOSITS IN SITING VALLEY		
●	1. Undifferentiated Deposits (A; map area in nm^2)	0	0
	a. Thickness (max./min./avg. in ft.)	N/A	
	b. Lithology	N/A	
	c. Seismic velocity (p/s in fps)	N/A	
●	2. Alluvial Fan Deposits (A_5; map area in nm^2)	78	58%
○	a. Thickness (max./min./avg. in ft.)		
◐	b. Lithology	Sand, Silt, grave	
○	c. Seismic velocity (p/s in fps)		
●	3. Playa Deposits (A_4; map area in nm^2)	0	0
	a. Thickness (max./min./avg. in ft.)	N/A	
	b. Lithology	N/A	
	c. Seismic velocity (p/s in fps)	N/A	
●	4. Wind-blown Sand (A_3; map area in nm^2)	0	0
	a. Thickness (max./min./avg. in ft.)	N/A	
	b. Lithology	N/A	
	c. Seismic velocity (p/s in fps)	N/A	
●	5. Pediment Deposits (A_6; map area in nm^2)		
○	a. Thickness (max./min./avg. in ft.)		
○	b. Lithology		
○	c. Seismic velocity (p/s in fps)		
●	6. Stream Channel and Floodplain Deposits (A_1; map area in nm^2)	54	40%
○	a. Thickness (max./min./avg. in ft.)		
◐	b. Lithology	Sand, silt, gra	
○	c. Seismic velocity (p/s in fps)		

Quality of Data
- ● Data derived from detailed studies
- ◐ Estimated values
- ○ Insufficient data available

372-A

ION			
-Fill Deposits			
LLEY			
map area	0	0	
t.)	N/A		
	N/A		
	N/A		
p area in nm2)	78	58%	
t.)			
	Sand, Silt, gravel		
in nm^2)	0	0	
t.)	N/A		
	N/A		
	N/A		
in nm^2)	0	0	
t.)	N/A		
	N/A		
	N/A		
rea in nm^2)			Extent unknown along south flank of Palomas Mountains
t.)			
n Deposits	54	40%	
t.)			
	Sand, silt, gravel		
)			

● 7. Terrace Deposits (A_2; map area in nm^2)

a. Thickness (max./min./avg. in ft.)

b. Lithology

c. Seismic velocity (p/s in fps)

○ 8. General Summary of Relationships

E. TECTONIC FRAMEWORK OF SITING VALLEY

● 1. Capable or Potentially Capable Fault

a. Total length (nm)

b. Relative location

c. Type of faulting, regional and local attitudes (strike and dip)

d. Minimum age of displacement or seismic activity (y.b.p.)

● 2. Volcanism

a. Volcanic flows

1) Location and map area in nm^2

2) Minimum age of volcanic activity (y.b.p.)

F. SEISMICITY OF SITING VALLEY (Regional seismicity discussed in Section 2.2.4 of text)

● 1. Relative Pre-Instrumental Historic Activity (Section 2.2.4)

◒ 2. Site Area Seismic Activity (instrumental, 1927-1973; Section 2.2.4)

◒ a. Events (epicenters) greater than M=6.0

◒ b. Events (epicenters) greater than M=1.0 and less than M=6.0

○ c. Events less than M=1.0 (includes microearthquakes)

◒ 3. Maximum Reported Modified Mercalli Intensity

◒ 4. Source of Possible Ground Acceleration Levels (Section 2.2.4)

◒ a. Maximum credible level (g)

◒ b. Most probable level (g)

G. Additional Remarks

O N			
in nm^2)	0	0	
	N/A		
	N/A		
	N/A		
s			
Fault	None		
	N/A		
	N/A		
ocal attitudes	N/A		
ismic activity	N/A		
	None		
	N/A		
	N/A		
ity	N/A		
al seismicity ric Activity	None		
trumental,			
M=6.0	None		
M=1.0 and less	None		
microearthquakes)			
lli Intensity	VI		
eration Levels	Salton Trough (Zone 1)	Transition Zone (Zone 2)	Diffuse Seismicity (Zone 3)
	0,25	0.05	0,2
		0.05	

SOILS ENGINEERING PROPERTIES (1)	MAP UNIT NUM	
	27	28
Unified soil classification (2)	GM-SM	GM,SM,ML
AASHO soil classification	A-1, A-2	A-1,A-2,or
Percent passing #4 sieve	35-80	40-95
Percent passing #40 sieve	30-55	40-65
Percent passing #200 sieve	15-35	25-50
Liquid limit/plasticity index	NP/NP	20-30/0-10
Surface consistency		
Dry density (pcf)		
Permeability (cm/sec)	10^{-2} to 10^{-4}	10^{-1} to 10^{-3}
In-situ shear strength (psi)		
In-situ angle of internal friction (degrees)		
Cohesion (psi)		
Shrink-swell potential	Low	Low
Coefficient of compressibility (in^2/lb.)		
In-situ CBR		
Recompacted CBR		
General surface moisture condition		
Compressional wave velocities (fps)		
Shear wave velocities (fps)		
Deleterious substances	Caliche present in some areas	Sulfates pr in some are
ENGINEERING DESIGN EVALUATIONS (1)		
Suitability as impermeable membrane when recompacted	Poor	Poor
Suitability as source of sand/fill material	Fair/Good	Poor/Fair
Suitability as source of aggregate/base course	Fair/Fair	Fair/Fair
Near surface foundation design characteristics	Mod. Strength Low comp.	Mod. strengt
Excavation limitations and slope angle	Sloughing and/or difficult ripping	Sloughing 45°-60°
Additional Remarks	High alkaline; corrosive to uncoated steel; ($A5_{QT}$; $A5c_Q$)	High alkali corrosive t uncoated st possible su corrosion o concrete; ($A5_Q$)

Explanation

(blank box)	No literature available and data not extrapolated
(SP-SM)	No literature available and data extrapolated
SP-SM	Data available in literature

(1) Surface soils only, depth of less than 5 feet

(2) Related geologic unit(s) shown in Additional Remarks (e.g., $A1_Q$)

...RING PROPERTIES (1)	MAP UNIT NUMBER 27	28	33
...ssification (2)	GM-SM	GM,SM,ML	GM,SM,SP,ML,CL
...sification	A-1, A-2	A-1,A-2,or A-4	A-2,A-4,A-6 or A-7
... #4 sieve	35-80	40-95	45-100
... #40 sieve	30-55	40-65	30-100
... #200 sieve	15-35	25-50	50-100
...asticity index	NP/NP	20-30/0-10	10-45/NP-30
...ency			
...f)			
...m/sec)	10^{-2} to 10^{-4}	10^{-1} to 10^{-3}	10^{-2} to 10^{-4}
...strength (psi)			
...of internal friction (degrees)			
...tential	Low	Low	Low to moderate
... compressibility (in^2/lb.)			
...R			
...e moisture condition			
...wave velocities (fps)			
...ocities (fps)			
...stances	Caliche present in some areas	Sulfates present in some areas	
...DESIGN EVALUATIONS (1)			
... impermeable membrane when recompacted	Poor	Poor	Fair to Poor
... source of sand/fill material	Fair/Good	Poor/Fair	Fair/Fair
... source of aggregate/base course	Fair/Fair	Fair/Fair	Fair/Fair
...oundation design characteristics	Mod. Strength Low comp.	Mod. strength	Low strength Mod. comp.
...itations and slope angle	Sloughing and/or difficult ripping	Sloughing 45^{o}-60^{o}	45^{o}-60^{o}
Additional Remarks	High alkaline; corrosive to uncoated steel; ($A5_{QT}$; $A5c_{Q}$)	High alkaline; corrosive to uncoated steel; possible sulfate corrosion of concrete; ($A5_{Q}$)	Subject to flooding; (Al_{Q})

...literature available and data not extrapolated
...literature available and data extrapolated
...available in literature
...Surface soils only, depth of less than 5 feet
...Related geologic unit(s) shown in Additional Remarks (e.g., Al_{Q})

QUALITY OF DATA	DESCRIPTION	
	A. SURFACE WATER IN SITING VALLEY	
●	1. Playas; Intermittent and Perennial Lakes	None
	a. Duration of surface water (wks.)	N/A
	b. Maximum extent (nm^2)	N/A
	c. Water depth (avg. in ft.)	N/A
	d. Source of water	N/A
	e. Water quality	N/A
◒	2. Springs	None
	a. Duration of flow (wks.)	N/A
	b. Estimated maximum flow rate (gpm/season)	N/A
	c. Water quality	N/A
◒	3. Rivers or Streams	Numerous unnamed streams
◒	a. Rate (gpm) and duration of flow (wks.)	Ephemeral
○	b. Water quality	
	B. HYDROLOGIC CHARACTERISTICS OF SITING VALLEY	
◒	1. Drainage Channel (PR=Primary; S=Secondary)	Numerous unnamed washes
◒	a. Depth of incision (max./min./avg.; ft.)	5/less than 1/0.5 to 1
◒	b. Width (max./min./avg.; ft.)	/ / 3 to 4
◒	c. Gradient (ft./mi.)	20 to 30
◒	d. Channel bottom characteristics	Sand, gravel
◒	e. Channel cross-section (schematic)	
◒	f. Channel spacing (avg. in ft.)	15 to 20
○	g. Preliminary flood susceptibility rating (Section 2.4.1)	
○	2. Preliminary Flood Susceptibility Rating of Major Landform Surfaces (Section 2.4.1)	Area mapped as Al_Q in ce subject to rill wash
○	a. Undifferentiated deposits	
○	b. Alluvial fans	
○	c. Playas (active=a; mantled=m)	
○	d. Pediments	
○	e. Sand dunes	
○	f. Terraces (l=lake; r=river)	
	C. ADDITIONAL REMARKS	Observations are based m interpretation of topogr

Quality of Data

● Data derived from detailed studies

◒ Estimated values

○ Insufficient data available

ɪ P T I O N	
ʌALLEY and Perennial Lakes	None
water (wks.)	N/A
	N/A
ɪ ft.)	N/A
	N/A
	N/A
	None
ts.)	N/A
low rate (gpm/season)	N/A
	N/A
	Numerous unnamed streams
tion of flow (wks.)	Ephemeral
ICS OF SITING VALLEY =Primary; S=Secondary)	Numerous unnamed washes
max./min./avg.; ft.)	5/less than 1/0.5 to 1
g.; ft.)	/ / 3 to 4
	20 to 30
acteristics	Sand, gravel
on (schematic)	
g. in ft.)	15 to 20
usceptibility rating	
ısceptibility Rating of ıces (Section 2.4.1)	Area mapped as Al_Q in central King Valley subject to rill wash
posits	
antled=m)	
=river)	
	Observations are based mainly on a brief field reconnaissance and interpretation of topographic maps and aerial photographs.

QUALITY OF DATA	DESCRIPTION			
	A. DEPTH TO GROUNDWATER WITHIN BASIN-FILL MATERIAL IN SITING VALLEY (Map area in nm2)			
◐	1. 0 to 50 feet	0	0	
◐	a. 0 to 25 feet	0	0	
◐	b. 25 to 50 feet	0	0	
◐	2. 50 to 100 feet	0	0	
◐	3. Greater than 100 feet	119	89%	Less th
◐	4. Unknown or not Present	15	11%	Unknown,
	B. AQUIFER CHARACTERISTICS IN VALLEY			
◐	1. Type of Aquifer (B=Basin Fill; P=Perched; R=Rock; u=unconfined; c=confined)	Bc		
○	a. Map area and extent			
◐	b. Depth to aquifer (ft.)	785		
◐	c. Thickness (ft.)	200		2
◐	d. Composition	Clay and sand		Sa
○	e. Porosity (%)			
○	f. Specific yield (%)			
○	g. Transmissivity (ft.^{2}/day)			
○	h. Specific capacity (gpm/ft. of drawdown)			
○	i. Total pumpage (ac. ft./unit time)			
◐	j. Groundwater ownership rights	YPG		
	C. WATER BUDGET FOR VALLEY			
○	1. Total Recharge (ac. ft./unit time)			
○	2. Total Discharge (ac. ft./unit time)			
	D. ADDITIONAL REMARKS	(a) Perched water levels		

Quality of Data
- ● Data derived from detailed studies
- ◐ Estimated values
- ○ Insufficient data available

I O N			
BASIN-FILL p area			
	0	0	
	0	0	
	0	0	
	0	0	
	119	89%	Less than 200 to 300 feet
	15	11%	Unknown, but probably greater than 300 feet, if present

ALLEY Fill; P=Perched; confined)	Bc	P	P See Additional Remarks (a)
	785	65	120
	200	25	3
	Clay and sand	Sand	Sand
)			
. of drawdown)			
it time)			
hts	YPG		
/unit time)			
/unit time)			
	(a) Perched water levels caused by clay layers		

QUALITY OF DATA	DESCRIPTION			
	A. VALLEY AREA, OWNERSHIP AND LAND UTILIZATION			
●	1. Area of Valley	$67 nm^2$	100%	
●	a. Area of valley excluded by major cultural or quantity-distance exclusions and 10% grade exclusion	$28 nm^2$	42%	
●	2. Area of Siting Valley (A.1 minus A.1.a)	$39 nm^2$	58%	
●	3. Ownership	DoD, U.S. Army, Yuma Prov		
●	a. Portion of siting valley with direct DoD ownership	$39 nm^2$	100%	
●	b. Co-owners or administrators of co-use land/ constraints	None		
◒	4. Contiguous BLM or Co-Use Land (area in nm^2)	>1000	BLM (Palomas Pla	
◒	a. Relative location in or adjacent to valley	Adjacent to Valley east a		
○	b. Present use			
	B. CULTURAL AND QUANTITY-DISTANCE EXCLUSIONS			
●	1. Location of 18 nm Arc (population greater than 25,000)	None		
●	2. Location of 3 nm Arc (population greater than 5,000)	None		
●	3. Other	None		
	C. CULTURAL IMPROVEMENTS			
◒	1. Roads/Railroads (name)	Unnamed roads and jeep tr		
◒	a. Relative location in valley	Randomly transect Valley		
◒	b. Type and use	Unimproved; military and		
●	2. Utilities (type)	None		
	a. Relative location in valley	N/A		
●	D. MILITARY/GOVERNMENTAL USE AREAS	Kofa Range		
●	1. Location and areal extent (nm^2)	Entire Valley, $67 nm^2$		
●	2. Present use	Limited munitions and wea		
○	3. Future use			
○	4. Decontamination necessary prior to siting			
	E. ADDITIONAL REMARKS			

Quality of Data
- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

DESCRIPTION			
, OWNERSHIP AND LAND UTILIZATION			
Valley	$67nm^2$	100%	
of valley excluded by major cultural uantity-distance exclusions and 10% e exclusion	$28nm^2$	42%	
Siting Valley (A.1 minus A.1.a)	$39nm^2$	58%	
ip	DoD, U.S. Army, Yuma Proving Grounds		
ion of siting valley with direct DoD rship	$39nm^2$	100%	
wners or administrators of co-use land/ traints	None		
ous BLM or Co-Use Land (area)	>1000	BLM (Palomas Plain)	
tive location in or adjacent to valley	Adjacent to Valley east and north of YPG boundary		
ent use			
D QUANTITY-DISTANCE EXCLUSIONS			
on of 18 nm Arc (population greater ,000)	None		
on of 3 · Arc (population greater ,000)	None		
	None		
PROVEMENTS			
Railroads (name)	Unnamed roads and jeep trails		
tive location in valley	Randomly transect Valley		
and use	Unimproved; military and restricted civilian		
es (type)	None		
tive location in valley	N/A		
OVERNMENTAL USE AREAS	Kofa Range		
on and areal extent (nm^2)	Entire Valley, $67nm^2$		
t use	Limited munitions and weapons testing		
use			
amination necessary prior to siting			
REMARKS			
etailed studies			
vailable			

QUALITY OF DATA	DESCRIPTION			
	A. TOPOGRAPHIC GRADIENT IN SITING VALLEY			
●	1. Area with Less than 10% Grade	39nm^2	100%	
●	2. Area with 5 to 10% Grade	1nm^2	3%	
●	3. Area with 0 to 5% Grade	38nm^2	97%	
●	4. Location of Alluvial Passes or Valley Boundaries Having Less than 10% Grade	Southern and western portion		
	B. ROCK CONDITIONS IN SITING VALLEY (BR=Basement, B=Bedrock, VF=Volcanic Flows)			
●	1. Exposed Rock (category/symbol/lithology)	B/I2$_T$/andesitic to basaltic		
●	a. Location and map area in nm^2	1	3%	Along flan
○	b. Seismic velocity (p/s in fps)			
	c. Conditions of volcanic flow	N/A		
◒	2. Pediments (rock type)	None		
	a. Location and map area in nm^2	0	0	N/A
	b. Exposure condition	N/A		
	c. Distance into siting valley from rock exposures (max./min./avg.) (nm)	N/A		
	C. SUBSURFACE ROCK CONDITIONS IN SITING VALLEY (BR=Basement, B=Bedrock, VF=Volcanic Flows)			
	1. Depth to Rock (map area in nm^2)			
◒	a. 0 to 250 feet (excluding pediments)	28	71%	
◒	1) Type	BR, B		
○	2) Seismic velocity (p/s in fps)			
○	b. 250 to 500 feet			
○	1) Type			
○	2) Seismic velocity (p/s in fps)			
○	c. 500 to 1000 feet			
○	1) Type			
○	2) Seismic velocity (p/s in fps)			
○	d. Greater than 1000 feet			
○	1) Type			
○	2) Seismic velocity (p/s in fps)			
◒	e. Unknown	10	26%	Greater th

Quality of Data

● Data derived from detailed studies

◒ Estimated values

○ Insufficient data available

N			
	$39nm^2$	100%	
	$1nm^2$	3%	
	$38nm^2$	97%	
lley rade	Southern and western portions contiguous with King Valley across Valley boundary		
Flows) hology)	B/I2$_T$/andesitic to basaltic volcanics		
	1	3%	Along flanks of Tank and Palomas Mountains
	N/A		
	None		
	0	0	N/A
	N/A		
ck	N/A		
VALLEY Flows)			
	28	71%	
	BR, B		
	10	26%	Greater than 250 feet, maximum depth unknown

QUALITY OF DATA	DESCRIPTION		
○	2. Rock (Section 2.2.3) in Basin-Fill Deposits (map area in nm^2)		
○	a. Type		
○	b. Depth to (ft.)		
○	c. Thickness (ft.)		
○	d. Seismic velocity (p/s in fps)		
	D. BASIN-FILL DEPOSITS IN SITING VALLEY		
●	1. Undifferentiated Deposits (A; map area in nm^2)	0	0
	a. Thickness (max./min./avg. in ft.)	N/A	
	b. Lithology	N/A	
	c. Seismic velocity (p/s in fps)	N/A	
●	2. Alluvial Fan Deposits (A_5; map area in nm^2)	38	97%
○	a. Thickness (max./min./avg. in ft.)		
◐	b. Lithology	Sand, silt, gr	
○	c. Seismic velocity (p/s in fps)		
●	3. Playa Deposits (A_4; map area in nm^2)	0	0
	a. Thickness (max./min./avg. in ft.)	N/A	
	b. Lithology	N/A	
	c. Seismic velocity (p/s in fps)	N/A	
●	4. Wind-blown Sand (A_3; map area in nm^2)	0	0
	a. Thickness (max./min./avg. in ft.)	N/A	
	b. Lithology	N/A	
	c. Seismic velocity (p/s in fps)	N/A	
●	5. Pediment Deposits (A_6; map area in nm^2)	0	0
	a. Thickness (max./min./avg. in ft.)	N/A	
	b. Lithology	N/A	
	c. Seismic velocity (p/s in fps)	N/A	
●	6. Stream Channel and Floodplain Deposits (A_1; map area in nm^2)		
○	a. Thickness (max./min./avg. in ft.)		
○	b. Lithology		
○	c. Seismic velocity (p/s in fps)		

Quality of Data

● Data derived from detailed studies

◐ Estimated values

○ Insufficient data available

SCRIPTION			
3) in Basin-Fill Deposits			
(p/s in fps)			
SITING VALLEY eposits (A; map area	0	0	
in./avg. in ft.)	N/A		
	N/A		
(p/s in fps)	N/A		
its (A_5; map area in nm^2)	38	97%	
in./avg. in ft.)			
	Sand, silt, gravel		
(p/s in fps)			
; map area in nm^2)	0	0	
in./avg. in ft.)	N/A		
	N/A		
(p/s in fps)	N/A		
$_3$; map area in nm^2)	0	0	
in./avg. in ft.)	N/A		
	N/A		
(p/s in fps)	N/A		
(A_6; map area in nm^2)	0	0	
in./avg. in ft.)	N/A		
	N/A		
(p/s in fps)	N/A		
Floodplain Deposits m^2)			Present, but not mappable at 1:62,500 scale
in./avg. in ft.)			
(p/s in fps)			

es

QUALITY OF DATA	D E S C R I P T I O N	
●	7. Terrace Deposits (A_2; map area in nm^2)	0
	a. Thickness (max./min./avg. in ft.)	N/A
	b. Lithology	N/A
	c. Seismic velocity (p/s in fps)	N/A
○	8. General Summary of Relationships	
	E. TECTONIC FRAMEWORK OF SITING VALLEY	
●	1. Capable or Potentially Capable Fault	None
	a. Total length (nm)	N/A
	b. Relative location	N/A
	c. Type of faulting, regional and local attitudes (strike and dip)	N/A
	d. Minimum age of displacement or seismic activity (y.b.p.)	N/A
●	2. Volcanism	None
	a. Volcanic flows	N/A
	1) Location and map area in nm^2	N/A
	2) Minimum age of volcanic activity (y.b.p.)	N/A
	F. SEISMICITY OF SITING VALLEY (Regional seismicity discussed in Section 2.2.4 of text)	
●	1. Relative Pre-Instrumental Historic Activity (Section 2.2.4)	None
◒	2. Site Area Seismic Activity (instrumental, 1927-1973; Section 2.2.4)	
◒	a. Events (epicenters) greater than M=6.0	None
◒	b. Events (epicenters) greater than M=1.0 and less than M=6.0	None
○	c. Events less than M=1.0 (includes microearthquakes)	
◒	3. Maximum Reported Modified Mercalli Intensity	VI
◒	4. Source of Possible Ground Acceleration Levels (Section 2.2.4)	Salton T
◒	a. Maximum credible level (g)	0.12
◒	b. Most probable level (g)	
	G. Additional Remarks	

Quality of Data

● Data derived from detailed studies

◒ Estimated values

○ Insufficient data available

N			
nm^{2})	0	0	
	N/A		
	N/A		
	N/A		
ult	None		
	N/A		
	N/A		
l attitudes	N/A		
ic activity	N/A		
	None		
	N/A		
	N/A		
y	N/A		
seismicity c Activity	None		
umental,			
5.0	None		
1.0 and less	None		
croearthquakes)			
i Intensity	VI		
ation Levels	Salton Trough (Zone 1)	Transition Zone (Zone 2)	Diffuse Seismicity (Zone 3)
	0.12	0.05	0.2
		0.05	

1

2

SOILS ENGINEERING PROPERTIES(1)	MAP UNIT NUMBER 27
Unified soil classification (2)	GM-SM
AASHO soil classification	A-1, A-2
Percent passing #4 sieve	35-80
Percent passing #40 sieve	30-55
Percent passing #200 sieve	15-35
Liquid limit/plasticity index	NP/NP
Surface consistency	
Dry density (pcf)	
Permeability (cm/sec)	10^{-2} to 10^{-4}
In-situ shear strength (psi)	
In-situ angle of internal friction (degrees)	
Cohesion (psi)	
Shrink-swell potential	Low
Coefficient of compressibility (in^2/lb.)	
In-situ CBR	
Recompacted CBR	
General surface moisture condition	
Compressional wave velocities (fps)	
Shear wave velocities (fps)	
Deleterious substances	Caliche present in some areas
ENGINEERING DESIGN EVALUATIONS(1)	
Suitability as impermeable membrane when recompacted	Poor
Suitability as source of sand/fill material	Fair/Good
Suitability as source of aggregate/base course	Fair/Fair
Near surface foundation design characteristics	Mod. strength Low comp.
Excavation limitations and slope angle	Sloughing and/or difficult ripping

Explanation

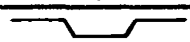
(empty box)	No literature available and data not extrapolated
(SP-SM)	No literature available and data extrapolated
SP-SM	Data available in literature

(1) Surface soils only, depth of less than 5 feet
(2) Related geologic unit(s) shown in Additional Remarks (e.g., Al_Q)

Additional Remarks: Highly alkaline; corrosive to uncoated steel; ($A5_{QT}$, $A5c_Q$)

QUALITY OF DATA	DESCRIPTION		
	A. SURFACE WATER IN SITING VALLEY		
●	1. Playas; Intermittent and Perennial Lakes	None	
	a. Duration of surface water (wks.)	N/A	
	b. Maximum extent (nm^2)	N/A	
	c. Water depth (avg. in ft.)	N/A	
	d. Source of water	N/A	
	e. Water quality	N/A	
◒	2. Springs	None	
	a. Duration of flow (wks.)	N/A	
	b. Estimated maximum flow rate (gpm/season)	N/A	
	c. Water quality	N/A	
◒	3. Rivers or Streams	Hoodoo Wash	Nu
◒	a. Rate (gpm) and duration of flow (wks.)	Ephemeral	Ep
○	b. Water quality		
	B. HYDROLOGIC CHARACTERISTICS OF SITING VALLEY		
◒	1. Drainage Channel (PR=Primary; S=Secondary)	Hoodoo Wash (PR)	Nu
○	a. Depth of incision (max./min./avg.; ft.)		
◒	b. Width (max./min./avg.; ft.)	200/75 est./	
◒	c. Gradient (ft./mi.)	40 to 50	40
◒	d. Channel bottom characteristics	Sand, gravel	Sa
◒	e. Channel cross-section (schematic)		
◒	f. Channel spacing (avg. in ft.)	Primary drainages, 0.	
○	g. Preliminary flood susceptibility rating (Section 2.4.1)		
○	2. Preliminary Flood Susceptibility Rating of Major Landform Surfaces (Section 2.4.1)		
○	a. Undifferentiated deposits		
○	b. Alluvial fans		
○	c. Playas (active=a; mantled=m)		
○	d. Pediments		
○	e. Sand dunes		
○	f. Terraces (l=lake; r=river)		
	C. ADDITIONAL REMARKS	Observations are based interpretation of topo	

Quality of Data
- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

PTION		
LLEY nd Perennial Lakes	None	
ter (wks.)	N/A	
	N/A	
t.)	N/A	
	N/A	
	N/A	
	None	
)	N/A	
rate (gpm/season)	N/A	
	N/A	
	Hoodoo Wash	Numerous unnamed streams
n of flow (wks.)	Ephemeral	Ephemeral
OF SITING VALLEY imary; S=Secondary)	Hoodoo Wash (PR)	Numerous unnamed washes (PR and S)
./min./avg.; ft.)		
ft.)	200/75 est./	
	40 to 50	40 to 50
eristics	Sand, gravel	Sand, gravel
(schematic)		
in ft.)	Primary drainages, 0.5 to 1 nm; Secondary drainages, 100 to 200 feet	
eptibility rating		
eptibility Rating of s (Section 2.4.1)		
its		
led=m)		
ver)		
	Observations are based mainly on a brief field reconnaissance and interpretation of topographic maps and aerial photographs.	

QUALITY OF DATA	DESCRIPTION			
	A. DEPTH TO GROUNDWATER WITHIN BASIN-FILL MATERIAL IN SITING VALLEY (Map area in nm2)			
○	1. 0 to 50 feet			
○	a. 0 to 25 feet			
○	b. 25 to 50 feet			
○	2. 50 to 100 feet			
○	3. Greater than 100 feet			
◒	4. Unknown or not Present	39	100%	
	B. AQUIFER CHARACTERISTICS IN VALLEY			
○	1. Type of Aquifer (B=Basin Fill; P=Perched; R=Rock; u=unconfined; c=confined)			
○	a. Map area and extent			
○	b. Depth to aquifer (ft.)			
○	c. Thickness (ft.)			
○	d. Composition			
○	e. Porosity (%)			
○	f. Specific yield (%)			
○	g. Transmissivity (ft^2/day)			
○	h. Specific capacity (gpm/ft. of drawdown)			
○	i. Total pumpage (ac. ft./unit time)			
○	j. Groundwater ownership rights			
	C. WATER BUDGET FOR VALLEY			
○	1. Total Recharge (ac. ft./unit time)			
○	2. Total Discharge (ac. ft./unit time)			
	D. ADDITIONAL REMARKS			

Quality of Data
- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

I O N			
BASIN-FILL ap area			
	39	100%	Unknown, but probably greater than 100 feet, if present
ALLEY Fill; P=Perched; confined)			
)			
. of drawdown)			
it time)			
hts			
/unit time)			
/unit time)			

QUALITY OF DATA	DESCRIPTION			
	A. VALLEY AREA, OWNERSHIP AND LAND UTILIZATION			
●	1. Area of Valley	$314nm^2$	100%	
●	a. Area of valley excluded by major cultural or quantity-distance exclusions and 10% grade exclusion	$203nm^2$	65%	
●	2. Area of Siting Valley (A.1 minus A.1.a)	$111nm^2$	35%	
●	3. Ownership	DoD, U.S. Air Force,		
●	a. Portion of siting valley with direct DoD ownership	$111nm^2$	100%	
●	b. Co-owners or administrators of co-use land/ constraints	Entire Valley co-adm U.S. Marine Corps Ai		
◒	4. Contiguous BLM or Co-Use Land (area in nm^2)	20	BLM (Yuma D	
◒	a. Relative location in or adjacent to valley	Adjacent to Valley n		
○	b. Present use			
	B. CULTURAL AND QUANTITY-DISTANCE EXCLUSIONS			
●	1. Location of 18 nm Arc (population greater than 25,000)	Northern and western		
●	2. Location of 3 nm Arc (population greater than 5,000)	None		
●	3. Other	None		
	C. CULTURAL IMPROVEMENTS			
◒	1. Roads/Railroads (name)	Unnamed roads and je		
◒	a. Relative location in valley	Subparallel and adja		
◒	b. Type and use	Unimproved; military		
◒	2. Utilities (type)	None		
	a. Relative location in valley	N/A		
●	D. MILITARY/GOVERNMENTAL USE AREAS	Air-to-Air Range		
●	1. Location and areal extent (nm^2)	Entire Valley, 314nm		
●	2. Present use	Radio controlled air Yuma		
○	3. Future use			
◒	4. Decontamination necessary prior to siting	Ordnance present,		
	E. ADDITIONAL REMARKS			

Quality of Data
- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

ON	$314nm^2$	100%
l	$203nm^2$	65%
a)	$111nm^2$	35%
	DoD, U.S. Air Force, Luke AFB	
	$111nm^2$	100%
and/	Entire Valley co-administered: Luke AFB, Litchfield Park, and U.S. Marine Corps Air Station, Yuma	
	20	BLM (Yuma Desert)
ley	Adjacent to Valley north of LWBGR boundary	
s eater	Northern and western portion of Valley from Yuma, Arizona	
ater	None	
	None	
	Unnamed roads and jeep trails	
	Subparallel and adjacent to west flank of Gila and Tinajas Atlas Mountains	
	Unimproved; military and restricted civilian	
	None	
	N/A	
	Air-to-Air Range Entire Valley, $314nm^2$	
	Radio controlled air-to-air combat training conducted by U.S, Marine Corps Air Station, Yuma	
iting	Ordnance present, but type unknown	

QUALITY OF DATA	DESCRIPTION			
	A. TOPOGRAPHIC GRADIENT IN SITING VALLEY			
●	1. Area with Less than 10% Grade	$111nm^2$	100%	
●	2. Area with 5 to 10% Grade	$1nm^2$	1%	
●	3. Area with 0 to 5% Grade	$110nm^2$	99%	
●	4. Location of Alluvial Passes or Valley Boundaries Having Less than 10% Grade	Eastern portion of Cipriano and Tinaj		
	B. ROCK CONDITIONS IN SITING VALLEY (BR=Basement, B=Bedrock, VF=Volcanic Flows)			
◒	1. Exposed Rock (category/symbol/lithology)	BR/Il_{MP}/granitics		
◒	a. Location and map area in nm^2	1	1%	A
○	b. Seismic velocity (p/s in fps)			
	c. Conditions of volcanic flow	N/A		
◒	2. Pediments (rock type)	None		
	a. Location and map area in nm^2	0	0	N
	b. Exposure condition	N/A		
	c. Distance into siting valley from rock exposures (max./min./avg.) (nm)	N/A		
	C. SUBSURFACE ROCK CONDITIONS IN SITING VALLEY (BR=Basement, B=Bedrock, VF=Volcanic Flows)			
	1. Depth to Rock (map area in nm^2)			
◒	a. 0 to 250 feet (excluding pediments)	33	30%	
◒	1) Type	BR		
○	2) Seismic velocity (p/s in fps)			
◒	b. 250 to 500 feet	21	19%	
◒	1) Type	BR		
○	2) Seismic velocity (p/s in fps)			
◒	c. 500 to 1000 feet	21	19%	
◒	1) Type	BR		
○	2) Seismic velocity (p/s in fps)			
◒	d. Greater than 1000 feet	35	31%	
◒	1) Type	BR		
○	2) Seismic velocity (p/s in fps)			
◒	e. Unknown	0	0	

Quality of Data

● Data derived from detailed studies

◒ Estimated values

○ Insufficient data available

RIPTION			
TING VALLEY % Grade	$111nm^2$	100%	
de	$1nm^2$	1%	
e	$110nm^2$	99%	
asses or Valley than 10% Grade	Eastern portion of Valley connects with Lechuguilla Desert by Cipriano and Tinajas Altas Passes.		
Y F=Volcanic Flows) /symbol/lithology)	BR/Il_{MP}/granitics		
in nm^2	1	1%	Along west flanks of Gila and Tinajas Atlas Mtns.
in fps)			
flow	N/A		
	None		
in nm^2	0	0	N/A
	N/A		
alley from rock vg.) (nm)	N/A		
S IN SITING VALLEY VF=Volcanic Flows) ea in nm^2)			
ng pediments)	33	30%	
	BR		
(p/s in fps)			
	21	19%	
	BR		
(p/s in fps)			
	21	19%	
	BR		
(p/s in fps)			
t	35	31%	
	BR		
(p/s in fps)			
	0	0	

D. BASIN-FILL DEPOSITS IN SITING VALLEY

1. Undifferentiated Deposits (A; map area in nm^2)

   a. Thickness (max./min./avg. in ft.)

   b. Lithology

   c. Seismic velocity (p/s in fps)

2. Alluvial Fan Deposits (A_5; map area in nm^2)

   a. Thickness (max./min./avg. in ft.)

   b. Lithology

   c. Seismic velocity (p/s in fps)

3. Playa Deposits (A_4; map area in nm^2)

   a. Thickness (max./min./avg. in ft.)

   b. Lithology

   c. Seismic velocity (p/s in fps)

4. Wind-blown Sand (A_3; map area in nm^2)

   a. Thickness (max./min./avg. in ft.)

   b. Lithology

   c. Seismic velocity (p/s in fps)

5. Pediment Deposits (A_6; map area in nm^2)

   a. Thickness (max./min./avg. in ft.)

   b. Lithology

   c. Seismic velocity (p/s in fps)

6. Stream Channel and Floodplain Deposits (A_1; map area in nm^2)

   a. Thickness (max./min./avg. in ft.)

   b. Lithology

   c. Seismic velocity (p/s in fps)

SCRIPTION			
.3) in Basin-Fill Deposits			
(p/s in fps)			
IN SITING VALLEY Deposits (A; map area	1	1%	
/min./avg. in ft.)			
	Silt, sand, gravel; may be calicified		
(p/s in fps)			
osits (A_5; map area in nm^2)	104	94%	
/min./avg. in ft.)			
	Sand, silt, gravel		
(p/s in fps)			
A_4; map area in nm^2)	0	0	
/min./avg. in ft.)	N/A		
	N/A		
(p/s in fps)	N/A		
(A_3; map area in nm^2)	5	4%	
/min./avg. in ft.)	/ /30		
	Sand, silt		
(p/s in fps)			
(A_6; map area in nm^2)	0	0	
/min./avg. in ft.)	N/A		
	N/A		
(p/s in fps)	N/A		
nd Floodplain Deposits nm^2)			Present, but not mappable at 1:62,000 scale
/min./avg. in ft.)			
y (p/s in fps)			

ies

7. Terrace Deposits (A_2; map area in nm^2)

a. Thickness (max./min./avg. in ft.)

b. Lithology

c. Seismic velocity (p/s in fps)

8. General Summary of Relationships

E. TECTONIC FRAMEWORK OF SITING VALLEY

1. Capable or Potentially Capable Fault

a. Total length (nm)

b. Relative location

c. Type of faulting, regional and local attitudes (strike and dip)

d. Minimum age of displacement or seismic activity (y.b.p.)

2. Volcanism

a. Volcanic flows

1) Location and map area in nm^2

2) Minimum age of volcanic activity (y.b.p.)

F. SEISMICITY OF SITING VALLEY (Regional seismicity discussed in Section 2.2.4 of text)

1. Relative Pre-Instrumental Historic Activity (Section 2.2.4)

2. Site Area Seismic Activity (instrumental, 1927-1973; Section 2.2.4)

a. Events (epicenters) greater than M=6.0

b. Events (epicenters) greater than M=1.0 and less than M=6.0

c. Events less than M=1.0 (includes microearthquakes)

3. Maximum Reported Modified Mercalli Intensity

4. Source of Possible Ground Acceleration Levels (Section 2.2.4)

a. Maximum credible level (g)

b. Most probable level (g)

O N			
in nm2)	0	0	
	N/A		
	N/A		
	N/A		
s			
Fault	Algodones Fault (capable)		
	Approximately 60		
	Transects central portion of Valley		
cal attitudes	Strike-slip; strike N40°W; high angle		
ismic activity	Last displacement approximately 200,000		
	None		
	N/A		
	N/A		
ity	N/A		
l seismicity ric Activity	Low		
rumental,	None		
=6.0	None		
=1.0 and less			
icroearthquakes)			
li Intensity	VIII		
ration Levels	Salton Trough (Zone 1)	Transition Zone (Zone 2)	Diffuse Seismicity (Zone 3)
	0.75+	0.05	0.2
		0.05	

SOILS ENGINEERING PROPERTIES (1)	27	28
Unified soil classification (2)	GM-SM	GM,SM,ML
AASHO soil classification	A-1, A-2	A-1,A-2,
Percent passing #4 sieve	35-80	40-95
Percent passing #40 sieve	30-55	40-65
Percent passing #200 sieve	15-35	25-50
Liquid limit/plasticity index	NP/NP	20-30/0-10
Surface consistency		
Dry density (pcf)		
Permeability (cm/sec)	10^{-2} to 10^{-4}	10^{-1} to 10
In-situ shear strength (psi)		
In-situ angle of internal friction (degrees)		
Cohesion (psi)		
Shrink-swell potential	Low	Low
Coefficient of compressibility (in^2/lb.)		
In-situ CBR		
Recompacted CBR		
General surface moisture condition		
Compressional wave velocities (fps)		
Shear wave velocities (fps)		
Deleterious substances	Caliche present in some areas	Sulfate p in some a
ENGINEERING DESIGN EVALUATIONS (1)		
Suitability as impermeable membrane when recompacted	Poor	Poor
Suitability as source of sand/fill material	Fair/Good	Poor/Fair
Suitability as source of aggregate/base course	Fair/Fair	Fair/Fair
Near surface foundation design characteristics	Mod. strength Low comp.	Mod. stre
Excavation limitations and slope angle	Sloughing and/or difficult ripping	Sloughing 45°-60°
Additional Remarks	Highly alkaline; corrosive to uncoated steel; ($A5_T$)	High alka corrosive uncoated possible corrosion concrete; ($A5_Q$)

Explanation

(blank box)	No literature available and data not extrapolated
(SP-SM)	No literature available and data extrapolated
SP-SM	Data available in literature

(1) Surface soils only, depth of less than 5 feet

(2) Related geologic unit(s) shown in Additional Remarks (e.g., Al_Q)

(1)	MAP UNIT NUMBER			
	27	28	30	31
	GM-SM	GM,SM,ML	SP-SM	CM,SM,ML,CL
	A-1, A-2	A-1,A-2, or A-4	A-2	A-2,A-4,or A-6
	35-80	40-95		45-100
	30-55	40-65		30-85
	15-35	25-50		20-75
	NP/NP	20-30/0-10		0-40/0-25
	10^{-2} to 10^{-4}	10^{-1} to 10^{-3}	10^{-1} to 10^{-3}	10^{-1} to 10^{-4}
(degrees)				
	Low	Low	Low	Low to moderate
2/lb.)				
l				
)				
	Caliche present in some areas	Sulfate present in some areas		
IS(1)				
e when recompacted	Poor	Poor	Poor	Poor
l material	Fair/Good	Poor/Fair	Good/Fair	Poor/Fair
/base course	Fair/Fair	Fair/Fair	Poor/Fair	Poor/Poor
racteristics	Mod. strength Low comp.	Mod. strength	Mod. stre[illegible]th High comp.	Mod. strength Mod. expan.
ngle	Sloughing and/or difficult ripping	Sloughing 45°-60°	Severe sloughing	Ravelling 45°-60°
and data not extrapolated and data extrapolated ature depth of less than 5 feet it(s) shown in Additional — Additional Remarks	Highly alkaline; corrosive to uncoated steel; ($A5_T$)	High alkaline; corrosive to uncoated steel; possible sulfate corrosion of concrete; ($A5_Q$)	Possible wind erosion and areas of high compressibility; ($A3_Q$)	(A_Q)

QUALITY OF DATA	DESCRIPTION	
	A. SURFACE WATER IN SITING VALLEY	
●	1. Playas; Intermittent and Perennial Lakes	None
	a. Duration of surface water (wks.)	N/A
	b. Maximum extent (nm^2)	N/A
	c. Water depth (avg. in ft.)	N/A
	d. Source of water	N/A
	e. Water quality	N/A
◒	2. Springs	None
	a. Duration of flow (wks.)	N/A
	b. Estimated maximum flow rate (gpm/season)	N/A
	c. Water quality	N/A
◒	3. Rivers or Streams	Numerous unnamed strea
◒	a. Rate (gpm) and duration of flow (wks.)	Ephemeral
○	b. Water quality	
	B. HYDROLOGIC CHARACTERISTICS OF SITING VALLEY	
◒	1. Drainage Channel (PR=Primary; S=Secondary)	Numerous unnamed washe
○	a. Depth of incision (max./min./avg.; ft.)	
○	b. Width (max./min./avg.; ft.)	
◒	c. Gradient (ft./mi.)	40 to 80
◒	d. Channel bottom characteristics	Sand, gravel
○	e. Channel cross-section (schematic)	
◒	f. Channel spacing (avg. in ft.)	100 to 200
○	g. Preliminary flood susceptibility rating (Section 2.4.1)	
○	2. Preliminary Flood Susceptibility Rating of Major Landform Surfaces (Section 2.4.1)	
○	a. Undifferentiated deposits	
○	b. Alluvial fans	
○	c. Playas (active=a; mantled=m)	
○	d. Pediments	
○	e. Sand dunes	
○	f. Terraces (l=lake; r=river)	
	C. ADDITIONAL REMARKS	Observations are based interpretation of topo

Quality of Data
- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

PTION	
LLEY nd Perennial Lakes	None
ter (wks.)	N/A
	N/A
t.)	N/A
	N/A
	N/A
	None
.)	N/A
rate (gpm/season)	N/A
	N/A
	Numerous unnamed streams
on of flow (wks.)	Ephemeral
S OF SITING VALLEY rimary; S=Secondary)	Numerous unnamed washes (S)
x./min./avg.; ft.)	
; ft.)	
	40 to 80
teristics	Sand, gravel
(schematic)	
in ft.)	100 to 200
ceptibility rating	
ceptibility Rating of es (Section 2.4.1)	
sits	
tled=m)	
iver)	
	Observations are based mainly on a brief aerial reconnaissance and interpretation of topographic maps and limited aerial photographs.

QUALITY OF DATA	DESCRIPTION		
	A. DEPTH TO GROUNDWATER WITHIN BASIN-FILL MATERIAL IN SITING VALLEY (Map area in nm^2)		
○	1. 0 to 50 feet		
○	a. 0 to 25 feet		
○	b. 25 to 50 feet		
○	2. 50 to 100 feet		
◐	3. Greater than 100 feet	109	98%
◐	4. Unknown or not Present	2	2%
	B. AQUIFER CHARACTERISTICS IN VALLEY		
◐	1. Type of Aquifer (B=Basin Fill; P=Perched; R=Rock; u=unconfined; c=confined)	Bu	
○	a. Map area and extent		
◐	b. Depth to aquifer (ft.)	285 (minimum)	
○	c. Thickness (ft.)		
◐	d. Composition	Sand and gravel	
○	e. Porosity (%)		
○	f. Specific yield (%)		
◐	g. Transmissivity ($ft.^2$/day)	40,000 to 107,00	
○	h. Specific capacity (gpm/ft. of drawdown)		
○	i. Total pumpage (ac. ft./unit time)		
●	j. Groundwater ownership rights	U.S. Bureau of Re	
	C. WATER BUDGET FOR VALLEY		
○	1. Total Recharge (ac. ft./unit time)		
○	2. Total Discharge (ac. ft./unit time)		
	D. ADDITIONAL REMARKS		

Quality of Data

- ● Data derived from detailed studies
- ◐ Estimated values
- ○ Insufficient data available

T I O N			
BASIN-FILL (Map area			
	109	98%	Less than 300 to 500 feet
	2	2%	Unknown, but probably greater than 500 feet, if present
VALLEY			
in Fill; P=Perched; c=confined)	Bu		
	285 (minimum)		
	Sand and gravel		
y)	40,000 to 107,000		
/ft. of drawdown)			
/unit time)			
ights	U.S. Bureau of Reclamation owns wells; Luke AFB		
./unit time)			
t./unit time)			

QUALITY OF DATA	DESCRIPTION		
	A. VALLEY AREA, OWNERSHIP AND LAND UTILIZATION		
●	1. Area of Valley	330nm^2	100%
●	a. Area of valley excluded by major cultural or quantity-distance exclusions and 10% grade exclusion	75nm^2	23%
●	2. Area of Siting Valley (A.1 minus A.1.a)	255nm^2	77%
●	3. Ownership	DoD, U.S. Air Force, I	
●	a. Portion of siting valley with direct DoD ownership	255nm^2	100%
●	b. Co-owners or administrators of co-use land/ constraints	Entire Valley co-admi Air Station, Yuma. S vision of U.S. Fish a	
◒	4. Contiguous BLM or Co-Use Land (area in nm^2)	20	BLM (Mohawk
◒	a. Relative location in or adjacent to valley	Adjacent to Valley no	
○	b. Present use		
	B. CULTURAL AND QUANTITY-DISTANCE EXCLUSIONS		
●	1. Location of 18 nm Arc (population greater than 25,000)	Northwestern portion	
●	2. Location of 3 nm Arc (population greater than 5,000)	None	
●	3. Other	None	
	C. CULTURAL IMPROVEMENTS		
◒	1. Roads/Railroads (name)	Camino del Diablo and	
◒	a. Relative location in valley	Parallel south DoD bo	
◒	b. Type and use	Unimproved; military	
◒	2. Utilities (type)	None	
	a. Relative location in valley	N/A	
●	D. MILITARY/GOVERNMENTAL USE AREAS	Air-to-Air Range	
●	1. Location and areal extent (nm^2)	Entire Valley, 330nm^2	
●	2. Present use	Radio controlled air- Marine Corps Air Stat	
○	3. Future use		
◒	4. Decontamination necessary prior to siting	Ordnance present, but	
	E. ADDITIONAL REMARKS		

Quality of Data
- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

N	
ION	$330nm^2$ 100%
al	$75nm^2$ 23%
.a)	$255nm^2$ 77%
	DoD, U.S. Air Force, Luke AFB
D	$255nm^2$ 100%
land/	Entire Valley co-administered; Luke AFB, Litchfield Park, and U.S. Marine Corps Air Station, Yuma. Southeastern portion (Cabeza Prieta Game Range) under supervision of U.S. Fish and Wildlife Service; approximately $90nm^2$
	20 BLM (Mohawk Valley)
lley	Adjacent to Valley north of LWBGR boundary
S / reater	Northwestern portion of Valley from Yuma, Arizona
eater	None
	None
	Camino del Diablo and Border Patrol Road / Unnamed roads and jeep trails
	Parallel south DoD boundary / Transect Valley, predominantly in northwest-southeast directions
	Unimproved; military and restricted civilian
	None
	N/A
	Air-to-Air Range
	Entire Valley, $330nm^2$
	Radio controlled air-to-air combat training conducted by U.S. Marine Corps Air Station, Yuma
siting	Ordnance present, but type unknown

QUALITY OF DATA	DESCRIPTION
	A. TOPOGRAPHIC GRADIENT IN SITING VALLEY
●	1. Area with Less than 10% Grade
●	2. Area with 5 to 10% Grade
●	3. Area with 0 to 5% Grade
●	4. Location of Alluvial Passes or Valley Boundaries Having Less than 10% Grade
	B. ROCK CONDITIONS IN SITING VALLEY (BR=Basement, B=Bedrock, VF=Volcanic Flows)
◓	1. Exposed Rock (category/symbol/lithology)
◓	a. Location and map area in nm^2
○	b. Seismic velocity (p/s in fps)
	c. Conditions of volcanic flow
◓	2. Pediments (rock type)
○	a. Location and map area in nm^2
○	b. Exposure condition
○	c. Distance into siting valley from rock exposures (max./min./avg.) (nm)
	C. SUBSURFACE ROCK CONDITIONS IN SITING VALLEY (BR=Basement, B=Bedrock, VF=Volcanic Flows)
	1. Depth to Rock (map area in nm^2)
◓	a. 0 to 250 feet (excluding pediments)
◓	1) Type
○	2) Seismic velocity (p/s in fps)
○	b. 250 to 500 feet
○	1) Type
○	2) Seismic velocity (p/s in fps)
○	c. 500 to 1000 feet
○	1) Type
○	2) Seismic velocity (p/s in fps)
○	d. Greater than 1000 feet
○	1) Type
○	2) Seismic velocity (p/s in fps)
◓	e. Unknown

Quality of Data

● Data derived from detailed studies

◓ Estimated values

○ Insufficient data available

$255nm^2$	100%	
$4nm^2$	2%	
$251nm^2$	98%	

Western portion of Valley connects with Yuma Desert by Cipriano and Tinajas Altas Passes
Eastern portion contiguous with Mohawk-Tule Valley across Valley boundary

BR/I2$_{MP}$, M$_{MP}$/andesitic to basaltic volcanics; gneiss, schist

3	1%	Along flanks of Gila, Tinajas Atlas, Copper, Cabeza Prieta and Tule Mountains, Wellton Hills, and as isolated masses in southeast portion of Valley.

N/A

None

0	0	N/A

N/A

N/A

118	46%	

BR

134	53%	Greater than 250 feet, maximum depth unknown

QUALITY OF DATA	DESCRIPTION	
○	2. Rock (Section 2.2.3) in Basin-Fill Deposits (map area in nm^2)	
○	a. Type	
○	b. Depth to (ft.)	
○	c. Thickness (ft.)	
○	d. Seismic velocity (p/s in fps)	
	D. BASIN-FILL DEPOSITS IN SITING VALLEY	
●	1. Undifferentiated Deposits (A; map area in nm^2)	0
	a. Thickness (max./min./avg. in ft.)	N/A
	b. Lithology	N/A
	c. Seismic velocity (p/s in fps)	N/A
●	2. Alluvial Fan Deposits (A_5; map area in nm^2)	244
○	a. Thickness (max./min./avg. in ft.)	
◐	b. Lithology	Sand, s
○	c. Seismic velocity (p/s in fps)	
●	3. Playa Deposits (A_4; map area in nm^2)	0
	a. Thickness (max./min./avg. in ft.)	N/A
	b. Lithology	N/A
	c. Seismic velocity (p/s in fps)	N/A
●	4. Wind-blown Sand (A_3; map area in nm^2)	0
	a. Thickness (max./min./avg. in ft.)	N/A
	b. Lithology	N/A
	c. Seismic velocity (p/s in fps)	N/A
●	5. Pediment Deposits (A_6; map area in nm^2)	0
	a. Thickness (max./min./avg. in ft.)	N/A
	b. Lithology	N/A
	c. Seismic velocity (p/s in fps)	N/A
●	6. Stream Channel and Floodplain Deposits (A_1; map area in nm^2)	8
○	a. Thickness (max./min./avg. in ft.)	
◐	b. Lithology	Sand, s
○	c. Seismic velocity (p/s in fps)	

Quality of Data

● Data derived from detailed studies
◐ Estimated values
○ Insufficient data available

3102-A

RIPTION			
n Basin-Fill Deposits			
in fps)			
ING VALLEY its (A; map area	0	0	
vg. in ft.)	N/A		
	N/A		
in fps)	N/A		
(A5; map area in nm^2)	244	95%	
vg. in ft.)			
	Sand, silt, gravel; may be calichified; may include fanglomerate		
in fps)			
p area in nm^2)	0	0	
vg. in ft.)	N/A		
	N/A		
in fps)	N/A		
ap area in nm^2)	0	0	
vg. in ft.)	N/A		
	N/A		
in fps)	N/A		
map area in nm^2)	0	0	
vg. in ft.)	N/A		
	N/A		
in fps)	N/A		
odplain Deposits	8	4%	
vg. in ft.)			
	Sand, silt, gravel		
in fps)			

QUALITY OF DATA	DESCRIPTION	
●	7. Terrace Deposits (A_2; map area in nm^2)	0
	a. Thickness (max./min./avg. in ft.)	N/A
	b. Lithology	N/A
	c. Seismic velocity (p/s in fps)	N/A
○	8. General Summary of Relationships	
	E. TECTONIC FRAMEWORK OF SITING VALLEY	
◒	1. Capable or Potentially Capable Fault	Sheep M
◒	a. Total length (nm)	20 (mini
◒	b. Relative location	In north
◒	c. Type of faulting, regional and local attitudes (strike and dip)	Trends a
○	d. Minimum age of displacement or seismic activity (y.b.p.)	
●	2. Volcanism	None
	a. Volcanic flows	N/A
	1) Location and map area in nm^2	N/A
	2) Minimum age of volcanic activity (y.b.p.)	N/A
	F. SEISMICITY OF SITING VALLEY (Regional seismicity discussed in Section 2.2.4 of text)	
◒	1. Relative Pre-Instrumental Historic Activity (Section 2.2.4)	Low
◒	2. Site Area Seismic Activity (instrumental, 1927-1973; Section 2.2.4)	
◒	a. Events (epicenters) greater than M=6.0	None
◒	b. Events (epicenters) greater than M=1.0 and less than M=6.0	None
○	c. Events less than M=1.0 (includes microearthquakes)	
◒	3. Maximum Reported Modified Mercalli Intensity	VII to V
◒	4. Source of Possible Ground Acceleration Levels (Section 2.2.4)	Salton
◒	a. Maximum credible level (g)	0.48
◒	b. Most probable level (g)	
	G. Additional Remarks	

Quality of Data
- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

3102-B

I O N			
in nm2)	0	0	
)	N/A		
	N/A		
	N/A		
ps			
Y Fault	Sheep Mountain Fault (potentially capable)		
	20 (minimum)		
	In northwest portion of Valley		
local attitudes	Trends approximately N50°W		
eismic activity			
	None		
	N/A		
	N/A		
vity	N/A		
nal seismicity oric Activity	Low		
strumental,			
M=6.0	None		
M=1.0 and less	None		
microearthquakes)			
alli Intensity	VII to VIII(?)		
leration Levels	Salton Trough (Zone 1)	Transition Zone (Zone 2)	Diffuse Seismicity (Zone 3)
	0.48	0.05	0.2
		0.05	

SOILS ENGINEERING PROPERTIES(1)	26	
Unified soil classification (2)	(GM-SM)	GM-S
AASHO soil classification	(A-1,A-2)	A-1,
Percent passing #4 sieve		35-80
Percent passing #40 sieve		30-55
Percent passing #200 sieve		15-35
Liquid limit/plasticity index		NP/NP
Surface consistency		
Dry density (pcf)		
Permeability (cm/sec)		10^{-2}
In-situ shear strength (psi)		
In-situ angle of internal friction (degrees)		
Cohesion (psi)		
Shrink-swell potential		
Coefficient of compressibility (in^2/lb.)		Low
In-situ CBR		
Recompacted CBR		
General surface moisture condition		
Compressional wave velocities (fps)		
Shear wave velocities (fps)		
Deleterious substances	Caliche present	Calich in so
ENGINEERING DESIGN EVALUATIONS(1)		
Suitability as impermeable membrane when recompacted	(Poor)	Poor
Suitability as source of sand/fill material	(Fair)/(Fair)	Fair/G
Suitability as source of aggregate/base course	(Fair)/(Fair)	Fair/F
Near surface foundation design characteristics	(High strength)	Mod. s Low co
Excavation limitations and slope angle	(Difficult ripping or blasting)	Slough diffic
Additional Remarks	Highly cemented; ($A5_T$)	Highly corros uncoat ($A5_{QT}$;

Explanation

(blank box)	No literature available and data not extrapolated
(SP-SM)	No literature available and data extrapolated
SP-SM	Data available in literature

(1) Surface soils only, depth of less than 5 feet
(2) Related geologic unit(s) shown in Additional Remarks (e.g. Al_Q)

	MAP UNIT NUMBER				
	26	27	28	29	33
	(GM-SM)	GM-SM	GM,SM,ML	(GM-SM)	GM,SM,SP,ML.CL
	(A-1,A-2)	A-1, A-2	A-1,A-2, or A-4	(A-1, A-2)	A-2,A-4,A-6,A-7
		35-80	40-95	.	45-100 .
		30-55	40-65		50-100
		15-35	25-50		50-100
		NP/NP	20-30/0-10		10-45/NP-30
		10^{-2} to 10^{-4}	10^{-1} to 10^{-3}		10^{-2} to 10^{-4}
		Low	Low		Low to moderate
	Caliche present	Caliche present in some areas	Sulfates present in some areas		
d	(Poor)	Poor	Poor	(Poor)	Fair to Poor
	(Fair)/(Fair)	Fair/Good	Poor/Fair	(Fair)/(Good)	Fair/Fair
	(Fair)/(Fair)	Fair/Fair	Fair/Fair	(Fair)/(Fair)	Fair/Fair
	(High strength)	Mod. strength Low comp.	Mod. strength	(Mod. strength)	Low strength Mod. comp.
	(Difficult ripping or blasting)	Sloughing and/or difficult ripping	Sloughing 45°-60°	(Difficult ripping or blasting)	45°-60°
rapolated lated n 5 feet litional — Additional Remarks	Highly cemented; ($A5_T$)	Highly alkaline; corrosive to uncoated steel; ($A5_{QT}$; $A5c_Q$)	Highly alkaline; corrosive to uncoated steel; possible sulfate corrosion of concrete; ($A5_Q$)	Depth to rock is less than 10 feet; ($A6_Q$)	Subject to flooding; ($A1_Q$)

QUALITY OF DATA	DESCRIPTION		
	A. SURFACE WATER IN SITING VALLEY		
●	1. Playas; Intermittent and Perennial Lakes	None	
	a. Duration of surface water (wks.)	N/A	
	b. Maximum extent (nm^2)	N/A	
	c. Water depth (avg. in ft.)	N/A	
	d. Source of water	N/A	
	e. Water quality	N/A	
◒	2. Springs	None	
	a. Duration of flow (wks.)	N/A	
	b. Estimated maximum flow rate (gpm/season)	N/A	
	c. Water quality	N/A	
◒	3. Rivers or Streams	Coyote Wash	Nume
◒	a. Rate (gpm) and duration of flow (wks.)	Ephemeral	Ephe
○	b. Water quality		
	B. HYDROLOGIC CHARACTERISTICS OF SITING VALLEY		
◒	1. Drainage Channel (PR=Primary; S=Secondary)	Coyote Wash (PR)	Nume
◒	a. Depth of incision (max./min./avg.; ft.)	/ / 3 to 4	
◒	b. Width (max./min./avg.; ft.)	3000/50 est./	
◒	c. Gradient (ft./mi.)	30	30 t
◒	d. Channel bottom characteristics	Sand, gravel	Sand
◒	e. Channel cross-section (schematic)		
◒	f. Channel spacing (avg. in ft.)	Main channel	
◒	g. Preliminary flood susceptibility rating (Section 2.4.1)	CP1	
○	2. Preliminary Flood Susceptibility Rating of Major Landform Surfaces (Section 2.4.1)		
○	a. Undifferentiated deposits		
○	b. Alluvial fans		
○	c. Playas (active=a; mantled=m)		
○	d. Pediments		
○	e. Sand dunes		
○	f. Terraces (l=lake; r=river)		
	C. ADDITIONAL REMARKS	Observations are based ma interpretation of topogra	

Quality of Data

● Data derived from detailed studies
◒ Estimated values
○ Insufficient data available

IPTION		
VALLEY and Perennial Lakes	None	
water (wks.)	N/A	
	N/A	
ft.)	N/A	
	N/A	
	N/A	
	None	
s.)	N/A	
low rate (gpm/season)	N/A	
	N/A	
	Coyote Wash	Numerous unnamed streams
tion of flow (wks.)	Ephemeral	Ephemeral
CS OF SITING VALLEY Primary; S=Secondary)	Coyote Wash (PR)	Numerous unnamed washes (S)
ax./min./avg.; ft.)	/ / 3 to 4	
g.; ft.)	3000/50 est./	
	30	30 to 50
cteristics	Sand, gravel	Sand, gravel
on (schematic)		
g. in ft.)	Main channel	
sceptibility rating	CP1	
sceptibility Rating of ces (Section 2.4.1)		
posits		
ntled=m)		
river)		
	Observations are based mainly on a brief aerial reconnaissance and interpretation of topographic maps and aerial photographs.	

QUALITY OF DATA	DESCRIPTION			
	A. DEPTH TO GROUNDWATER WITHIN BASIN-FILL MATERIAL IN SITING VALLEY (Map area in nm^2)			
○	1. 0 to 50 feet			
○	a. 0 to 25 feet			
○	b. 25 to 50 feet			
○	2. 50 to 100 feet			
◒	3. Greater than 100 feet	162	64%	Less
◒	4. Unknown or not Present	93	36%	Unkn
	B. AQUIFER CHARACTERISTICS IN VALLEY			
○	1. Type of Aquifer (B=Basin Fill; P=Perched; R=Rock; u=unconfined; c=confined)			
○	a. Map area and extent			
○	b. Depth to aquifer (ft.)			
○	c. Thickness (ft.)			
○	d. Composition			
○	e. Porosity (%)			
○	f. Specific yield (%)			
○	g. Transmissivity ($ft.^2$/day)			
○	h. Specific capacity (gpm/ft. of drawdown)			
○	i. Total pumpage (ac. ft./unit time)			
◒	j. Groundwater ownership rights	Luke AFB		
	C. WATER BUDGET FOR VALLEY			
○	1. Total Recharge (ac. ft./unit time)			
○	2. Total Discharge (ac. ft./unit time)			
	D. ADDITIONAL REMARKS			

Quality of Data

● Data derived from detailed studies
◒ Estimated values
○ Insufficient data available

I O N			
ASIN-FILL p area			
	162	64%	Less than 300 to 400 feet
	93	36%	Unknown, but probably greater than 400 feet, if present
ALLEY Fill; P=Perched; confined)			
)			
. of drawdown)			
it time)			
hts	Luke AFB		
unit time)			
/unit time)			

QUALITY OF DATA	DESCRIPTION			
	A. VALLEY AREA, OWNERSHIP AND LAND UTILIZATION			
●	1. Area of Valley	$853nm^2$	100%	
●	a. Area of valley excluded by major cultural or quantity-distance exclusions and 10% grade exclusion	$170nm^2$	20%	
●	2. Area of Siting Valley (A.1 minus A.1.a)	$683nm^2$	80%	
●	3. Ownership	DoD, U.S. Air Force,		
●	a. Portion of siting valley with direct DoD ownership	$683nm^2$	100%	
●	b. Co-owners or administrators of co-use land/ constraints	Co-administered area approximately $600nm^2$ (Cabeza Prieta Game		
◒	4. Contiguous BLM or Co-Use Land (area in nm^2)	20	BLM (Mohawk	
◒	a. Relative location in or adjacent to valley	Adjacent to Valley n		
○	b. Present use			
	B. CULTURAL AND QUANTITY-DISTANCE EXCLUSIONS			
●	1. Location of 18 nm Arc (population greater than 25,000)	None		
●	2. Location of 3 nm Arc (population greater than 5,000)	None		
●	3. Other	None		
	C. CULTURAL IMPROVEMENTS			
◒	1. Roads/Railroads (name)	Camino del Diablo and		
◒	a. Relative location in valley	Parallel south DoD b		
◒	b. Type and use	Unimproved; military		
◒	2. Utilities (type)	None		
	a. Relative location in valley	N/A		
●	D. MILITARY/GOVERNMENTAL USE AREAS	Air-to-Air Range		
●	1. Location and areal extent (nm^2)	Entire Valley except approximately $600nm^2$		
●	2. Present use	Radio controlled air- ducted by U.S. Marin		
○	3. Future use			
◒	4. Decontamination necessary prior to siting	Contamination present		
	E. ADDITIONAL REMARKS			

Quality of Data
- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

	$853nm^2$	100%	
	$170nm^2$	20%	
	$683nm^2$	80%	
	DoD, U.S. Air Force, Luke AFB		
	$683nm^2$	100%	
V	Co-administered area; Luke AFB, Litchfield Park and U.S. Marine Corps Air Station, Yuma, approximately $600nm^2$ in western and northern portion of Valley. Southern half of Valley (Cabeza Prieta Game Range) supervised by U.S. Fish and Wildlife Service, approx. $500nm^2$		
	20	BLM (Mohawk Valley)	
	Adjacent to Valley north of LWBGR boundary		
ter	None		
r	None		
	None		
	Camino del Diablo and Border Patrol Road	Unnamed roads and jeep trails	
	Parallel south DoD boundary	Transect Valley, predominantly north-south along its axis	
	Unimproved; military and restricted civilian		
	None		
	N/A		
	Air-to-Air Range Entire Valley except southern Mohawk Valley; approximately $600nm^2$	Air-to-Air Range Southern Mohawk Valley; approximately $250nm^2$	
	Radio controlled air-to-air combat training conducted by U.S. Marine Corps Air Station, Yuma	Air-to-air and air-to-ground combat and pilot training, conducted by Luke AFB	
ing	Contamination present, but type unknown	Contamination present, but type unknown	

QUALITY OF DATA	DESCRIPTION		
	A. TOPOGRAPHIC GRADIENT IN SITING VALLEY		
●	1. Area with Less than 10% Grade	683nm^2	100%
●	2. Area with 5 to 10% Grade	11nm^2	2%
●	3. Area with 0 to 5% Grade	672nm^2	98%
●	4. Location of Alluvial Passes or Valley Boundaries Having Less than 10% Grade	Western portion Eastern portion	
	B. ROCK CONDITIONS IN SITING VALLEY (BR=Basement, B=Bedrock, VF=Volcanic Flows)		
◓	1. Exposed Rock (category/symbol/lithology)	BR, B, VF/I^1_{MP},	
◓	a. Location and map area in nm^2	8	1%
○	b. Seismic velocity (p/s in fps)		
●	c. Conditions of volcanic flow	Pinacates Volca	
◓	2. Pediments (rock type)	BR; crystaline	
◓	a. Location and map area in nm^2	7	1%
◓	b. Exposure condition	Very thin mantl	
◓	c. Distance into siting valley from rock exposures (max./min./avg.) (nm)	1 nm/0.5/0.5	
	C. SUBSURFACE ROCK CONDITIONS IN SITING VALLEY (BR=Basement, B=Bedrock, VF=Volcanic Flows)		
	1. Depth to Rock (map area in nm^2)		
◓	a. 0 to 250 feet (exluding pediments)	207	30%
◓	1) Type	BR, B	
○	2) Seismic velocity (p/s in fps)		
○	b. 250 to 500 feet		
○	1) Type		
○	2) Seismic velocity (p/s in fps)		
○	c. 500 to 1000 feet		
○	1) Type		
○	2) Seismic velocity (p/s in fps)		
○	d. Greater than 1000 feet		
○	1) Type		
○	2) Seismic velocity (p/s in fps)		
◓	e. Unknown	461	68%

Quality of Data
- ● Data derived from detailed studies
- ◓ Estimated values
- ○ Insufficient data available

83nm^2	100%	
11nm^2	2%	
72nm^2	98%	

estern portion contiguous with Lechuguilla Desert across Valley boundary
astern portion contiguous with San Cristobal and Growler-Childs Valley across Valley boundary

R, B, VF/$I1_{MP}$, M_{MP}, $I2_T$, $I3_{QT}$/granitics, gneiss, schist, andesitic to basaltic volcanics, basalt

8	1%	Along flanks of Copper, Cabeza Prieta, Sierra Pinta, Mohawk, and Agua Dulce Mountains

inacates Volcanic Field: Low, rugged topography, may have thin mantle of basin-fill deposits

R; crystaline

7	1%	South flank of Agua Dulce Mountains

ery thin mantle of deposits

nm/0.5/0.5

07	30%	

R, B

61	68%	Greater than 250 feet, maximum depth unknown

QUALITY OF DATA	DESCRIPTION		
○	2. Rock (Section 2.2.3) in Basin-Fill Deposits (map area in nm^2)		
○	a. Type		
○	b. Depth to (ft.)		
○	c. Thickness (ft.)		
○	d. Seismic velocity (p/s in fps)		
	D. BASIN-FILL DEPOSITS IN SITING VALLEY		
●	1. Undifferentiated Deposits (A; map area in nm^2)	558	81%
○	a. Thickness (max./min./avg. in ft.)		
◒	b. Lithology	Silt, sand, grav	
○	c. Seismic velocity (p/s in fps)		
●	2. Alluvial Fan Deposits (A_5; map area in nm^2).		
○	a. Thickness (max./min./avg. in ft.)		
◒	b. Lithology	Sand, silt, grav	
○	c. Seismic velocity (p/s in fps)		
●	3. Playa Deposits (A_4; map area in nm^2)	2	1%
○	a. Thickness (max./min./avg. in ft.)		
◒	b. Lithology	Clay, sand, silt	
○	c. Seismic velocity (p/s in fps)		
●	4. Wind-blown Sand (A_3; map area in nm^2)	27	4%
○	a. Thickness (max./min./avg. in ft.)		
◒	b. Lithology	Sand, silt	
○	c. Seismic velocity (p/s in fps)		
●	5. Pediment Deposits (A_6; map area in nm^2)	7	1%
○	a. Thickness (max./min./avg. in ft.)		
◒	b. Lithology	Sand, gravel	
○	c. Seismic velocity (p/s in fps)		
●	6. Stream Channel and Floodplain Deposits (A_1; map area in nm^2)	26	4%
○	a. Thickness (max./min./avg. in ft.)		
◒	b. Lithology	Sand, silt, grav	
○	c. Seismic velocity (p/s in fps)		

Quality of Data
- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

3112-A

DESCRIPTION			
ion 2.2.3) in Basin-Fill Deposits n nm^2)			
(ft.)			
s (ft.)			
velocity (p/s in fps)			
OSITS IN SITING VALLEY			
tiated Deposits (A; map area	558	81%	
s (max./min./avg. in ft.)			
y	Silt, sand, gravel		
velocity (p/s in fps)			
an Deposits (A_5; map area in nm^2)			
s (max./min./avg. in ft.)			
y	Sand, silt, gravel, and cobbles; may be calichified		
velocity (p/s in fps)			
sits (A_4; map area in nm^2)	2	1%	
s (max./min./avg. in ft.)			
y	Clay, sand, silt		
velocity (p/s in fps)			
Sand (A_3; map area in nm^2)	27	4%	
s (max./min./avg. in ft.)			
y	Sand, silt		
velocity (p/s in fps)			
eposits (A_6; map area in nm^2)	7	1%	
s (max./min./avg. in ft.)			
y	Sand, gravel		
velocity (p/s in fps)			
nnel and Floodplain Deposits rea in nm^2)	26	4%	
s (max./min./avg. in ft.)			
y	Sand, silt, gravel		
velocity (p/s in fps)			

led studies

able

QUALITY OF DATA	DESCRIPTION	
●	7. Terrace Deposits (A_2; map area in nm^2)	0 | 0
	a. Thickness (max./min./avg. in ft.)	N/A
	b. Lithology	N/A
	c. Seismic velocity (p/s in fps)	N/A
○	8. General Summary of Relationships	
	E. TECTONIC FRAMEWORK OF SITING VALLEY	
◐	1. Capable or Potentially Capable Fault	None
	a. Total length (nm)	N/A
	b. Relative location	N/A
	c. Type of faulting, regional and local attitudes (strike and dip)	N/A
	d. Minimum age of displacement or seismic activity (y.b.p.)	
●	2. Volcanism	
●	a. Volcanic flows	Pinacates Volcani
●	1) Location and map area in nm^2	Along south centr
●	2) Minimum age of volcanic activity (y.b.p.)	Approximately 24,
	F. SEISMICITY OF SITING VALLEY (Regional seismicity discussed in Section 2.2.4 of text)	
◐	1. Relative Pre-Instrumental Historic Activity (Section 2.2.4)	Low
◐	2. Site Area Seismic Activity (instrumental, 1927-1973; Section 2.2.4)	
○	a. Events (epicenters) greater than M=6.0	None
◐	b. Events (epicenters) greater than M=1.0 and less than M=6.0	M=4.7 in 1963; M
○	c. Events less than M=1.0 (includes microearthquakes)	
◐	3. Maximum Reported Modified Mercalli Intensity	VI
◐	4. Source of Possible Ground Acceleration Levels (Section 2.2.4)	Salton Trough (Z
◐	a. Maximum credible level (g)	0.35
◐	b. Most probable level (g)	
	G. Additional Remarks	

Quality of Data
- ● Data derived from detailed studies
- ◐ Estimated values
- ○ Insufficient data available

3/12-B

m2)	0	0	
	N/A		
	N/A		
	N/A		
t	None		
	N/A		
	N/A		
attitudes	N/A		
c activity			
	Pinacates Volcanic Field		
	Along south central DoD boundary; approximately 10		
	Approximately 24,000		
eismicity Activity	Low		
ental,			
0	None		
0 and less	M=4.7 in 1963; M=4.4 in 1964		
oearthquakes)			
Intensity	VI		
tion Levels	Salton Trough (Zone 1)	Transition Zone (Zone 2)	Diffuse Seismicity (Zone 3)
	0.35	0.05	0.2
		0.05	

SOILS ENGINEERING PROPERTIES[1]	26
Unified soil classification[2]	(GM-SM)
AASHO soil classification	(A-1, A-2)
Percent passing #4 sieve	
Percent passing #40 sieve	
Percent passing #200 sieve	
Liquid limit/plasticity index	
Surface consistency	
Dry density (pcf)	
Permeability (cm/sec)	
In-situ shear strength (psi)	
In-situ angle of internal friction (degrees)	
Cohesion (psi)	
Shrink-swell potential	
Coefficient of compressibility (in^2/lb.)	
In-situ CBR	
Recompacted CBR	
General surface moisture condition	
Compressional wave velocities (fps)	
Shear wave velocities (fps)	
Deleterious substances	Caliche present
ENGINEERING DESIGN EVALUATIONS[1]	
Suitability as impermeable membrane when recompacted	(Poor)
Suitability as source of sand/fill material	(Fair)/(Fair)
Suitability as source of aggregate/base course	(Fair)/(Fair)
Near surface foundation design characteristics	(High strength)
Excavation limitations and slope angle	(Difficult rip-ing or blasting)
Additional Remarks	Highly cemented; ($A5_T$)

Explanation

(blank box)	No literature available and data not extrapolated
(SP-SM)	No literature available and data extrapolated
SP-SM	Data available in literature

(1) Surface soils only, depth of less than 5 feet

(2) Related geologic unit(s) shown in Additional Remarks (e.g. Al_Q)

MAP UNIT NUMBER					
26	27	28	29	30	31
(GM-SM)	GM-SM	GM, SM, ML	(GM-SM)	SP-SM	GM,SM,ML,CL
(A-1, A-2)	A-1, A-2	A-1, A-2, or A-4	(A-1, A-2)	A-2	A-2,A-4, or A-6
	35-80	40-95			45-100
	30-55	40-65			30-85
	15-35	25-50			20-75
	NP/NP	20-30/0-10			0-40/0-25
	10^{-2} to 10^{-4}	10^{-1} to 10^{-3}		10^{-1} to 10^{-3}	10^{-1} to 10^{-4}
	Low	Low		Low	Low to moderate
Caliche present	Caliche present in some areas	Sulfate present in some areas			
(Poor)	Poor	Poor	(Poor)	Poor	Poor
(Fair)/(Fair)	Fair/Good	Poor/Fair	(Fair)/(Good)	Good/Fair	Poor/Fair
(Fair)/(Fair)	Fair/Fair	Fair/Fair	(Fair)/(Fair)	Poor/Fair	Poor/Poor
(High strength)	Mod. strength Low comp.	Mod. strength	(Mod. strength)	Mod. strength High comp.	Mod. strength Mod. expan.
(Difficult ripping or blasting)	Sloughing and/or difficult ripping	Sloughing 45°-60°	(Difficult ripping or blasting)	Severe sloughing	Ravelling 45°-60°
Highly cemented; ($A5_T$)	High alkaline; corrosive to uncoated steel; ($A5_{QT}$; $A5c_Q$)	High alkaline; corrosive to uncoated steel; possible sulfate corrosion of concrete; ($A5_Q$)	Depth to rock less than 10 feet; ($A6_Q$)	Possible wind erosion and very high compressibility; ($A3_Q$)	(A_Q)

N 2

MAP UNIT NUMBER					
28	29	30	31	33	34
, ML	(GM-SM)	SP-SM	GM,SM,ML,CL	GM,SM,SP,ML,CL	(ML-CL)
-2, or A-4	(A-1, A-2)	A-2	A-2,A-4, or A-6	A-2,A-4,A-6, or A-7	(A-4 or A-6)
			45-100	45-100	
			30-85	30-100	
			20-75	50-100	
/0-10			0-40/0-25	10-45/NP-30	
o 10^{-3}		10^{-1} to 10^{-3}	10^{-1} to 10^{-4}	10^{-2} to 10^{-4}	
		Low	Low to moderate	Low to moderate	
e present e areas					
	(Poor)	Poor	Poor	Fair to Poor	(Fair)
air	(Fair)/(Good)	Good/Fair	Poor/Fair	Fair/Fair	NA/(Poor)
air	(Fair)/(Fair)	Poor/Fair	Poor/Poor	Fair/Fair	NA/(Poor)
trength	(Mod. strength)	Mod. strength High comp.	Mod. strength Mod. expan.	Low strength Mod. comp.	Low strength Mod. comp.
ing 0°	(Difficult ripping or blasting)	Severe sloughing	Ravelling 45°-60°	45°-60°	(>60°)
lkaline; ive to ed steel; le sulfate ion of te;	Depth to rock less than 10 feet; ($A6_Q$)	Possible wind erosion and very high compressibility; ($A3_Q$)	(A_Q)	Subject to flooding; ($A1_Q$)	Subject to possible flooding; ($A4_Q$)

2

QUALITY OF DATA	DESCRIPTION		
	A. SURFACE WATER IN SITING VALLEY		
●	1. Playas; Intermittent and Perennial Lakes	Pinta Playa	Lo:
○	a. Duration of surface water (wks.)		
◒	b. Maximum extent (nm^2)	0.5	1
○	c. Water depth (avg. in ft.)		
◒	d. Source of water	Direct precipitati	
○	e. Water quality		
◒	2. Springs	Agua Dulce Spring	
◒	a. Duration of flow (wks.)	Perennial (?)	
◒	b. Estimated maximum flow rate (gpm/season)	Less than 10 gal/d	
○	c. Water quality		
◒	3. Rivers or Streams	Mohawk Wash	
◒	a. Rate (gpm) and duration of flow (wks.)	Ephemeral	
○	b. Water quality		
	B. HYDROLOGIC CHARACTERISTICS OF SITING VALLEY		
◒	1. Drainage Channel (PR=Primary; S=Secondary)	Mohawk Wash (PR)	
◒	a. Depth of incision (max./min./avg.; ft.)	/ / 3 to 4	
◒	b. Width (max./min./avg.; ft.)	1500/75 est./	
◒	c. Gradient (ft./mi.)	20	
◒	d. Channel bottom characteristics	Sand, gravel, cobb	
◒	e. Channel cross-section (schematic)		
◒	f. Channel spacing (avg. in ft.)	Main channel	
◒	g. Preliminary flood susceptibility rating (Section 2.4.1)	CF1	
◒	2. Preliminary Flood Susceptibility Rating of Major Landform Surfaces (Section 2.4.1)		
○	a. Undifferentiated deposits		
○	b. Alluvial fans		
◒	c. Playas (active=a; mantled=m)	a: SF1	
○	d. Pediments		
○	e. Sand dunes		
○	f. Terraces (l=lake; r=river)		
	C. ADDITIONAL REMARKS	Observations are b interpretation of	

Quality of Data

● Data derived from detailed studies

◒ Estimated values

○ Insufficient data available

P T I O N				
ALLEY and Perennial Lakes	Pinta Playa	Los Playas	Dos Playas	Unnamed playa in south-central portion of Valley
ater (wks.)				
	0.5	1	0.5	0.25
ft.)				
	Direct precipitation and surface run-off			
	Agua Dulce Spring			
.)	Perennial (?)			
w rate (gpm/season)	Less than 10 gal/day			
	Mohawk Wash		Numerous unnamed streams	
ion of flow (wks.)	Ephemeral		Ephemeral	
CS OF SITING VALLEY Primary; S=Secondary)	Mohawk Wash (PR)		Numerous unnamed washes (S)	
ax./min./avg.; ft.)	/ / 3 to 4		/ / 3 to 4	
.; ft.)	1500/75 est./			
	20		20 to 30	
cteristics	Sand, gravel, cobbles		Sand, gravel, cobbles	
n (schematic)				
. in ft.)	Main channel			
sceptibility rating	CF1			
sceptibility Rating of ces (Section 2.4.1)				
osits				
ntled=m)	a: SF1			
river)				
	Observations are based mainly on a brief aerial reconnaissance and interpretation of topographic maps and aerial photographs.			

QUALITY OF DATA	DESCRIPTION			
	A. DEPTH TO GROUNDWATER WITHIN BASIN-FILL MATERIAL IN SITING VALLEY (Map area in nm2)			
○	1. 0 to 50 feet			
○	a. 0 to 25 feet			
○	b. 25 to 50 feet			
○	2. 50 to 100 feet			
◒	3. Greater than 100 feet	193	28%	Le
◒	4. Unknown or not Present	490	72%	Un
	B. AQUIFER CHARACTERISTICS IN VALLEY			
●	1. Type of Aquifer (B=Basin Fill; P=Perched; R=Rock; u=unconfined; c=confined)	Ru See Additional Remar		
○	a. Map area and extent			
●	b. Depth to aquifer (ft.)	225		
○	c. Thickness (ft.)			
●	d. Composition	Granite basement rock		
○	e. Porosity (%)			
○	f. Specific yield (%)			
○	g. Transmissivity (ft.^{2}/day)			
○	h. Specific capacity (gpm/ft. of drawdown)			
○	i. Total pumpage (ac. ft./unit time)			
●	j. Groundwater ownership rights	U.S. Bureau of Sport		
	C. WATER BUDGET FOR VALLEY			
○	1. Total Recharge (ac. ft./unit time)			
○	2. Total Discharge (ac. ft./unit time)			
	D. ADDITIONAL REMARKS	(a) Rock aquifer is		

Quality of Data

● Data derived from detailed studies
◒ Estimated values
○ Insufficient data available

I O N			
ASIN-FILL p area			
	193	28%	Less than 200 to 400 feet
	490	72%	Unknown, but probably greater than 400 feet, if present
LLEY			
Fill; P=Perched; onfined)	Ru See Additional Remarks (a)		
	225		
	Granite basement rock (Il_{MP})		
of drawdown)			
t time)			
ts	U.S. Bureau of Sport Fisheries and Wildlife owns well; Luke AFB		
nit time)			
/unit time)			
	(a) Rock aquifer is fracture system		

QUALITY OF DATA	DESCRIPTION		
	A. VALLEY AREA, OWNERSHIP AND LAND UTILIZATION		
●	1. Area of Valley	353nm²	100%
●	a. Area of valley excluded by major cultural or quantity-distance exclusions and 10% grade exclusion	34nm²	10%
●	2. Area of Siting Valley (A.1 minus A.1.a)	319nm²	90%
●	3. Ownership	DoD, U.S. Air Force	
●	a. Portion of siting valley with direct DoD ownership	319nm²	100%
●	b. Co-owners or administrators of co-use land/ constraints	Southern portion (C and Wildlife Servic	
◓	4. Contiguous BLM or Co-Use Land (area in nm²)	20	BLM
◓	a. Relative location in or adjacent to valley	Adjacent to Valley	
○	b. Present use		
	B. CULTURAL AND QUANTITY-DISTANCE EXCLUSIONS		
●	1. Location of 18 nm Arc (population greater than 25,000)	None	
●	2. Location of 3 nm Arc (population greater than 5,000)	None	
●	3. Other	None	
	C. CULTURAL IMPROVEMENTS		
◓	1. Roads/Railroads (name)	Unnamed roads and j	
◓	a. Relative location in valley	Transect Valley; pr	
◓	b. Type and use	Unimproved; militar	
◓	2. Utilities (type)	None	
	a. Relative location in valley	N/A	
●	D. MILITARY/GOVERNMENTAL USE AREAS	Air-to-Air Range	
●	1. Location and areal extent (nm²)	Southern portion of approximately 200 n	
●	2. Present use	Air-to-air and air- pilot training cond	
○	3. Future use		
◓	4. Decontamination necessary prior to siting	Contamination pres	
	E. ADDITIONAL REMARKS		

Quality of Data
- ● Data derived from detailed studies
- ◓ Estimated values
- ○ Insufficient data available

N			
ATION			
	353nm^2	100%	
ural 0%	34nm^2	10%	
.1.a)	319nm^2	90%	
	DoD, U.S. Air Force, Luke AFB		
DoD	319nm^2	100%	
land/	Southern portion (Cabeza Prieta Game Range) supervised by U.S. Fish and Wildlife Service; approximately 75nm^2		
	20	BLM	
valley	Adjacent to Valley north of LWBGR boundary		
ONS			
greater	None		
reater	None		
	None		
	Unnamed roads and jeep trails		
	Transect Valley; predominantly northwest-southeast direction along mountain flanks		
	Unimproved; military and restricted civilian		
	None		
	N/A		
	Air-to-Air Range Southern portion of Valley; approximately 200 nm^2		Target 53 Northern portion of Valley; approximately 150nm^2
	Air-to-air and air-to-ground combat and pilot training conducted by Luke AFB		Air-to-ground target training conducted by Luke AFB
o siting	Contamination present, but types unknown		Contamination present, but types unknown

QUALITY OF DATA	DESCRIPTION		
	A. TOPOGRAPHIC GRADIENT IN SITING VALLEY		
●	1. Area with Less than 10% Grade	319nm^2	100%
●	2. Area with 5 to 10% Grade	4nm^2	1%
●	3. Area with 0 to 5% Grade	315nm^2	99%
●	4. Location of Alluvial Passes or Valley Boundaries Having Less than 10% Grade	Western portion Eastern portion	
	B. ROCK CONDITIONS IN SITING VALLEY (BR=Basement, B=Bedrock, VF=Volcanic Flows)		
◒	1. Exposed Rock (category/symbol/lithology)	B/$I2_T$/andesitic	
◒	a. Location and map area in nm^2	1	1%
○	b. Seismic velocity (p/s in fps)		
	c. Conditions of volcanic flow	N/A	
◒	2. Pediments (rock type)	None	
	a. Location and map area in nm^2	0	0
	b. Exposure condition	N/A	
	c. Distance into siting valley from rock exposures (max./min./avg.) (nm)	N/A	
	C. SUBSURFACE ROCK CONDITIONS IN SITING VALLEY (BR=Basement, B=Bedrock, VF=Volcanic Flows)		
	1. Depth to Rock (map area in nm^2)		
◒	a. 0 to 250 feet (excluding pediments)	98	31%
◒	1) Type	BR, B	
○	2) Seismic velocity (p/s in fps)		
○	b. 250 to 500 feet		
○	1) Type		
○	2) Seismic velocity (p/s in fps)		
○	c. 500 to 1000 feet		
○	1) Type		
○	2) Seismic velocity (p/s in fps)		
○	d. Greater than 1000 feet		
○	1) Type		
○	2) Seismic velocity (p/s in fps)		
◒	e. Unknown	220	68%

Quality of Data

- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

I O N			
LLEY			
	$319nm^2$	100%	
	$4nm^2$	1%	
	$315nm^2$	99%	
r Valley 0% Grade	Western portion contiguous with Growler-Childs Valley across Valley boundary Eastern portion contiguous with Mohawk-Tule Valley across Valley boundary		
nic Flows) /lithology)	B/I2$_T$/andesitic to basaltic volcanics		
	1	1%	Along flanks of Mohawk, Bryan, Granite and Aguila Mountains
	N/A		
	None		
	0	0	N/A
	N/A		
m rock m)	N/A		
ING VALLEY nic Flows) 2)			
nts)	98	31%	
	BR, B		
ps)			
ps)			
ps)			
ps)			
	220	68%	Greater than 250 feet, maximum depth unknown

QUALITY OF DATA	DESCRIPTION		
○	2. Rock (Section 2.2.3) in Basin-Fill Deposits (map area in nm^2)		
○	a. Type		
○	b. Depth to (ft.)		
○	c. Thickness (ft.)		
○	d. Seismic velocity (p/s in fps)		
	D. BASIN-FILL DEPOSITS IN SITING VALLEY		
●	1. Undifferentiated Deposits (A; map area in nm^2)	110	34%
◐	a. Thickness (max./min./avg. in ft.)		
○	b. Lithology		
○	c. Seismic velocity (p/s in fps)		
●	2. Alluvial Fan Deposits (A_5; map area in nm^2)	175	54%
○	a. Thickness (max./min./avg. in ft.)		
◐	b. Lithology	Sand, silt, gr	
○	c. Seismic velocity (p/s in fps)		
●	3. Playa Deposits (A_4; map area in nm^2)	0	0
	a. Thickness (max./min./avg. in ft.)	N/A	
	b. Lithology	N/A	
	c. Seismic velocity (p/s in fps)	N/A	
●	4. Wind-blown Sand (A_3; map area in nm^2)	4	1%
○	a. Thickness (max./min./avg. in ft.)		
◐	b. Lithology	Sand, silt, gr	
○	c. Seismic velocity (p/s in fps)		
●	5. Pediment Deposits (A_6; map area in nm^2)	0	0
	a. Thickness (max./min./avg. in ft.)	N/A	
	b. Lithology	N/A	
	c. Seismic velocity (p/s in fps)	N/A	
●	6. Stream Channel and Floodplain Deposits (A_1; map area in nm^2)	28	9%
○	a. Thickness (max./min./avg. in ft.)		
◐	b. Lithology	Sand, silt, gr	
○	c. Seismic velocity (p/s in fps)		

Quality of Data
- ● Data derived from detailed studies
- ◐ Estimated values
- ○ Insufficient data available

3122-A

D E S C R I P T I O N			
n 2.2.3) in Basin-Fill Deposits nm^2)			
ft.)			
(ft.)			
locity (p/s in fps)			
ITS IN SITING VALLEY			
lated Deposits (A; map area	110	34%	
(max./min./avg. in ft.)			
locity (p/s in fps)			
Deposits (A_5; map area in nm^2)	175	54%	
(max./min./avg. in ft.)			
	Sand, silt, gravel		
locity (p/s in fps)			
its (A_4; map area in nm^2)	0	0	
(max./min./avg. in ft.)	N/A		
	N/A		
locity (p/s in fps)	N/A		
Sand (A_3; map area in nm^2)	4	1%	
(max./min./avg. in ft.)			
	Sand, silt, gravel; may be calichified		
locity (p/s in fps)			
posits (A_6; map area in nm^2)	0	0	
(max./min./avg. in ft.)	N/A		
	N/A		
locity (p/s in fps)	N/A		
nel and Floodplain Deposits ea in nm^2)	28	9%	
(max./min./avg. in ft.)			
	Sand, silt, gravel		
velocity (p/s in fps)			

d studies

le

QUALITY OF DATA	DESCRIPTION	
●	7. Terrace Deposits (A_2; map area in nm^2)	1
○	a. Thickness (max./min./avg. in ft.)	
◒	b. Lithology	Sand, silt
○	c. Seismic velocity (p/s in fps)	
○	8. General Summary of Relationships	
	E. TECTONIC FRAMEWORK OF SITING VALLEY	
◒	1. Capable or Potentially Capable Fault	None
	a. Total length (nm)	N/A
	b. Relative location	N/A
	c. Type of faulting, regional and local attitudes (strike and dip)	N/A
	d. Minimum age of displacement or seismic activity (y.b.p.)	N/A
●	2. Volcanism	None
	a. Volcanic flows	N/A
	1) Location and map area in nm^2	N/A
	2) Minimum age of volcanic activity (y.b.p.)	N/A
	F. SEISMICITY OF SITING VALLEY (Regional seismicity discussed in Section 2.2.4 of text)	
◒	1. Relative Pre-Instrumental Historic Activity (Section 2.2.4)	Low
◒	2. Site Area Seismic Activity (instrumental, 1927-1973; Section 2.2.4)	
○	a. Events (epicenters) greater than M=6.0	None
◒	b. Events (epicenters) greater than M=1.0 and less than M=6.0	M=5.0 in 19[illegible]
○	c. Events less than M=1.0 (includes microearthquakes)	
◒	3. Maximum Reported Modified Mercalli Intensity	IV
◒	4. Source of Possible Ground Acceleration Levels (Section 2.2.4)	Salton Troug[illegible]
◒	a. Maximum credible level (g)	0.21
◒	b. Most probable level (g)	
	G. Additional Remarks	

Quality of Data
● Data derived from detailed studies
◒ Estimated values
○ Insufficient data available

3/22-8

I O N			
in nm2)	1	1%	
.)			
	Sand, silt, gravel; may be calichified		
ips			
EY e Fault	None		
	N/A		
	N/A		
local attitudes	N/A		
seismic activity	N/A		
	None		
	N/A		
2	N/A		
ivity	N/A		
onal seismicity toric Activity	Low		
nstrumental,			
n M=6.0	None		
n M=1.0 and less	M=5.0 in 1958		
s microearthquakes)			
calli Intensity	IV		
leration Levels	Salton Trough (Zone 1)	Transition Zone (Zone 2)	Diffuse Seismicity (Zone 3)
	0.21	0.05	0.2
		0.05	

SOILS ENGINEERING PROPERTIES (1)	27	28
Unified soil classification (2)	GM-SM	GM, SM, M
AASHO soil classification	A-1, A-2	A-1, A-2,
Percent passing #4 sieve	35-80	40-95
Percent passing #40 sieve	30-55	40-65
Percent passing #200 sieve	15-35	25-50
Liquid limit/plasticity index	NP/NP	20-30/0-1
Surface consistency		
Dry density (pcf)		
Permeability (cm/sec)	10^{-2} to 10^{-4}	10^{-1} to 1
In-situ shear strength (psi)		
In-situ angle of internal friction (degrees)		
Cohesion (psi)		
Shrink-swell potential	Low	Low
Coefficient of compressibility (in^2/lb.)		
In-situ CBR		
Recompacted CBR		
General surface moisture condition		
Compressional wave velocities (fps)		
Shear wave velocities (fps)		
Deleterious substances	Caliche present in some areas	Sulfate p in some a
ENGINEERING DESIGN EVALUATIONS (1)		
Suitability as impermeable membrane when recompacted	Poor	Poor
Suitability as source of sand/fill material	Fair/Good	Poor/Fair
Suitability as source of aggregate/base course	Fair/Fair	Fair/Fair
Near surface foundation design characteristics	Mod. strength Low comp.	Mod. stre
Excavation limitations and slope angle	Sloughing and/or difficult ripping	Sloughing 45°-60°
Additional Remarks	Highly alkaline; corrosive to uncoated steel; ($A5_{QT}$; $A5c_Q$)	Highly al corrosiv uncoated possible corrosio concrete ($A5_Q$)

Explanation

(blank box)	No literature available and data not extrapolated
(SP-SM)	No literature available and data extrapolated
SP-SM	Data available in literature

(1) Surface soils only, depth of less than 5 feet

(2) Related geologic unit(s) shown in Additional Remarks (e.g. Al_Q)

MAP UNIT NUMBER					
27	28	30	31	32	33
M	GM, SM, ML	SP-SM	GM,SM,ML CL	(SM-ML)	GM,SM,SP,ML,CL
, A-2	A-1, A-2,or A-4	A-2	A-2, A-4, or A-6	(A-2 or A-4)	A-2,A-4,A-6,or A-7
00	40-95		45-100		45-100
55	40-65		30-85		30-100
35	25-50		20-75		50-100
NP	20-30/0-10		0-40/0-25		10-45/NP-30
2 to 10^{-4}	10^{-1} to 10^{-3}	10^{-1} to 10^{-3}	10^{-1} to 10^{-4}		10^{-2} to 10^{-4}
	Low	Low	Low to moderate		Low to moderate
iche present some areas	Sulfate present in some areas				
r	Poor	Poor	Poor	(Poor)	Fair to Poor
r/Good	Poor/Fair	Good/Fair	Poor/Fair	(Fair)/(Good)	Fair/Fair
r/Fair	Fair/Fair	Poor/Fair	Poor/Poor	(Fair)/(Fair)	Fair/Fair
. strength comp.	Mod. strength	Mod. strength Mod. comp.	Mod. strength Mod. expan.		Low strength Mod. comp.
ughing and/or ficult ripping	Sloughing 45^{o}-60^{o}	Severe sloughing	Ravelling 45^{o}-60^{o}		45^{o}-60^{o}
hly alkaline; rrosive to oated steel; $_{QT}$; A5c$_Q$)	Highly alkaline; corrosive to uncoated steel; possible sulfate corrosion of concrete; (A5$_Q$)	Possible wind erosion; areas of high compressibility; (A3$_Q$)	(A$_Q$)	(A2$_Q$)	Subject to flooding; (A1$_Q$)

AD-A113 214 FUGRO NATIONAL INC LONG BEACH CA F/G 8/6
MX SITING INVESTIGATION. VOLUME IIB. GEOTECHNICAL REPORT, YUMA --ETC(U)
JUN 75 F04701-74-C-0013
UNCLASSIFIED FN-TR-3-VOL-2B NL

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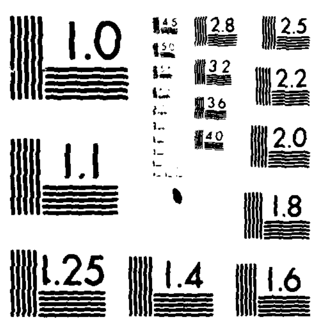

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS 1963 A

QUALITY OF DATA	DESCRIPTION	
	A. SURFACE WATER IN SITING VALLEY	
●	1. Playas; Intermittent and Perennial Lakes	None
	a. Duration of surface water (wks.)	N/A
	b. Maximum extent (nm^2)	N/A
	c. Water depth (avg. in ft.)	N/A
	d. Source of water	N/A
	e. Water quality	N/A
	2. Springs	None
◒	a. Duration of flow (wks.)	N/A
	b. Estimated maximum flow rate (gpm/season)	N/A
	c. Water quality	N/A
◒	3. Rivers or Streams	San Cristobal
◒	a. Rate (gpm) and duration of flow (wks.)	Ephemeral
○	b. Water quality	
	B. HYDROLOGIC CHARACTERISTICS OF SITING VALLEY	
◒	1. Drainage Channel (PR=Primary; S=Secondary)	San Cristobal
◒	a. Depth of incision (max./min./avg.; ft.)	/ / 2 to 3
◒	b. Width (max./min./avg.; ft.)	3000/100 est./
◒	c. Gradient (ft./mi.)	20
◒	d. Channel bottom characteristics	Sand. gravel
◒	e. Channel cross-section (schematic)	
◒	f. Channel spacing (avg. in ft.)	Main channel
◒	g. Preliminary flood susceptibility rating (Section 2.4.1)	CF1
○	2. Preliminary Flood Susceptibility Rating of Major Landform Surfaces (Section 2.4.1)	
○	a. Undifferentiated deposits	
○	b. Alluvial fans	
○	c. Playas (active=a; mantled=m)	
○	d. Pediments	
○	e. Sand dunes	
○	f. Terraces (l=lake; r=river)	
	C. ADDITIONAL REMARKS	Observations (interpretatio

Quality of Data

● Data derived from detailed studies

◒ Estimated values

○ Insufficient data available

PTION		
LLEY nd Perennial Lakes	None	
ter (wks.)	N/A	
	N/A	
t.)	N/A	
	N/A	
	N/A	
	None	
.)	N/A	
rate (gpm/season)	N/A	
	N/A	
	San Cristobal Wash	Numerous unnamed streams
on of flow (wks.)	Ephemeral	Ephemeral
S OF SITING VALLEY rimary; S=Secondary)	San Cristobal Wash (PR)	Numerous unnamed washes (S)
x./min./avg.; ft.)	/ / 2 to 3	/ / 1 to 2
; ft.)	3000/100 est./	
	20	20 to 30
teristics	Sand, gravel	Sand, gravel
(schematic)		
in ft.)	Main channel	
ceptibility rating	CF1	
ceptibility Rating of es (Section 2.4.1)		
its		
tled=m)		
iver)		
	Observations are based mainly on a brief aerial reconnaissance and interpretation of topographic maps and aerial photographs.	

QUALITY OF DATA	DESCRIPTION			
	A. DEPTH TO GROUNDWATER WITHIN BASIN-FILL MATERIAL IN SITING VALLEY (Map area in nm^2)			
○	1. 0 to 50 feet			
○	a. 0 to 25 feet			
○	b. 25 to 50 feet			
○	2. 50 to 100 feet			
◐	3. Greater than 100 feet	249	78%	L
◐	4. Unknown or not Present	70	22%	U
	B. AQUIFER CHARACTERISTICS IN VALLEY			
◐	1. Type of Aquifer (B=Basin Fill; P=Perched; R=Rock; u=unconfined; c=confined)	P See Additional Rema		
○	a. Map area and extent			
◐	b. Depth to aquifer (ft.)	40		
◐	c. Thickness (ft.)	20		
◐	d. Composition	Sand		
○	e. Porosity (%)			
○	f. Specific yield (%)			
○	g. Transmissivity ($ft.^2/day$)			
○	h. Specific capacity (gpm/ft. of drawdown)			
○	i. Total pumpage (ac. ft./unit time)			
◐	j. Groundwater ownership rights	Luke AFB		
	C. WATER BUDGET FOR VALLEY			
○	1. Total Recharge (ac. ft./unit time)			
○	2. Total Discharge (ac. ft./unit time)			
	D. ADDITIONAL REMARKS	(a) Perched water 60- and great		

Quality of Data

- ● Data derived from detailed studies
- ◐ Estimated values
- ○ Insufficient data available

I O N			
BASIN-FILL p area			
	249	78%	Less than 200 to 400 feet
	70	22%	Unknown, but probably greater than 400 feet, if present

ALLEY Fill; P=Perched; confined)	P See Additional Remarks (a)	P See Additional Remarks (a)
	40	122
	20	
	Sand	Sand and gravel
)		
t. of drawdown)		
it time)		
hts	Luke AFB	
/unit time)		
./unit time)		
	(a) Perched water levels caused by clay layers and caliche (?) at 60- and greater than 122-foot depths.	

QUALITY OF DATA	DESCRIPTION	
	A. VALLEY AREA, OWNERSHIP AND LAND UTILIZATION	
●	1. Area of Valley	603nm
●	a. Area of valley excluded by major cultural or quantity-distance exclusions and 10% grade exclusion	104nm
●	2. Area of Siting Valley (A.1 minus A.1.a)	499nm
●	3. Ownership	DoD,
●	a. Portion of siting valley with direct DoD ownership	499nm
●	b. Co-owners or administrators of co-use land/ constraints	South Fish
◒	4. Contiguous BLM or Co-Use Land (area in nm^2)	45
◒	a. Relative location in or adjacent to valley	Adjac
○	b. Present use	
	B. CULTURAL AND QUANTITY-DISTANCE EXCLUSIONS	
●	1. Location of 18 nm Arc (population greater than 25,000)	None
●	2. Location of 3 nm Arc (population greater than 5,000)	None
●	3. Other	1780
	C. CULTURAL IMPROVEMENTS	
◒	1. Roads/Railroads (name)	U.S.
◒	a. Relative location in valley	Tran of V
◒	b. Type and use	Impr
◒	2. Utilities (type)	Elec
◒	a. Relative location in valley	Para
●	**D. MILITARY/GOVERNMENTAL USE AREAS**	Air- Sout
●	1. Location and areal extent (nm^2)	appr
●	2. Present use	Air- and
○	3. Future use	
◒	4. Decontamination necessary prior to siting	Ord
	E. ADDITIONAL REMARKS	

Quality of Data

- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

O N			
ATION			
	603nm^2	100%	
tural 10%	104nm^2	17%	
.1.a)	499nm^2	83%	
	DoD, U.S. Air Force, Luke AFB		
DoD	499nm^2	100%	
e land/	Southern portion (Cabeza Prieta Game Range) supervised by U.S. Fish and Wildlife Service; approximately 300nm^2		
	45	BLM	
valley	Adjacent to Valley north of LWBGR boundary		
ONS			
greater	None		
reater	None		
	1780 foot exclusion corridor along U.S. 85		
	U.S. 85	Unnamed roads and jeep trails	
	Transects west-central portion of Valley, trends north-south	Randomly transects Valley	
	Improved; public highway	Unimproved and improved; military and restricted civilian	
	Electrical transmission lines		
	Parallel and adjacent to U.S. 85 and extending to Range #1		
	Air-to-Air Range Southern Growler Valley; approximately 200 nm^2	Target 53 Northwestern portion of Valley; approximately 100nm^2	North Tactical Ran Northern Childs Va approximately 100n
	Air-to-air and air-to-ground combat and pilot training conducted by Luke AFB	Air-to-ground target training conducted by Luke AFB	Air-to-ground targ conducted by Luke
siting	Ordance present, but type unknown	Ordance present, but type unknown	Ordance present, type unknown

e) supervised by U.S.
300nm^2

Unnamed roads and jeep trails

Randomly transects Valley
Unimproved and improved; military and restricted civilian

ding to Range #1

Target 53 Northwestern portion of Valley; approximately 100nm^2	North Tactical Range Northern Childs Valley; approximately 100nm^2	South Tactical Range Central portion of Valley; approximately 200nm^2
Air-to-ground target training conducted by Luke AFB	Air-to-ground target training conducted by Luke AFB	Air-to-ground target training conducted by Luke AFB
Ordance present, but type unknown	Ordance present, but type unknown	Ordance present, but type unknown

1

3

QUALITY OF DATA	DESCRIPTION		
	A. TOPOGRAPHIC GRADIENT IN SITING VALLEY		
●	1. Area with Less than 10% Grade	499nm^2	100%
●	2. Area with 5 to 10% Grade	18nm^2	4%
●	3. Area with 0 to 5% Grade	481nm^2	96%
●	4. Location of Alluvial Passes or Valley Boundaries Having Less than 10% Grade	Western portion co Eastern portion co	
	B. ROCK CONDITIONS IN SITING VALLEY (BR=Basement, B=Bedrock, VF=Volcanic Flows)		
◒	1. Exposed Rock (category/symbol/lithology)	B/I2$_T$, I2$_{MP}$/andesi	
◒	a. Location and map area in nm^2	3	1%
○	b. Seismic velocity (p/s in fps)		
●	c. Conditions of volcanic flow		
◒	2. Pediments (rock type)		
◒	a. Location and map area in nm^2	8	1%
◒	b. Exposure condition	Thin mantle of pedi	
◒	c. Distance into siting valley from rock exposures (max./min./avg.) (nm)	4/0.5/2	
	C. SUBSURFACE ROCK CONDITIONS IN SITING VALLEY (BR=Basement, B=Bedrock, VF=Volcanic Flows)		
	1. Depth to Rock (map area in nm^2)		
◒	a. 0 to 250 feet (excluding pediments)	134	27%
◒	1) Type	BR, B	
○	2) Seismic velocity (p/s in fps)		
○	b. 250 to 500 feet		
○	1) Type		
○	2) Seismic velocity (p/s in fps)		
○	c. 500 to 1000 feet		
○	1) Type		
○	2) Seismic velocity (p/s in fps)		
○	d. Greater than 1000 feet		
○	1) Type		
○	2) Seismic velocity (p/s in fps)		
◒	e. Unknown	354	71%

Quality of Data

● Data derived from detailed studies

◒ Estimated values

○ Insufficient data available

100%	
4%	
96%	
ortion contiguous with San Cristobal and Mohawk-Tule Valleys across Valley boundary	
ortion contiguous with Sentinel Plain across Valley boundary	
mp/andesitic to basaltic volcanics	
1%	Along flanks of Aguila, Granite, Aqua Dulce, Crater, Childs, Growler and Little Ajo Mountains
1%	Adjacent to Childs Mountain
le of pediment deposits	
27%	
71%	Greater than 250 feet, maximum depth unknown

QUALITY OF DATA	D E S C R I P T I O N		
○	2. Rock (Section 2.2.3) in Basin-Fill Deposits (map area in nm^2)		
○	a. Type		
○	b. Depth to (ft.)		
○	c. Thickness (ft.)		
○	d. Seismic velocity (p/s in fps)		
	D. BASIN-FILL DEPOSITS IN SITING VALLEY		
●	1. Undifferentiated Deposits (A; map area in nm^2)	274	55%
○	a. Thickness (max./min./avg. in ft.)		
◐	b. Lithology	Sand, silt, gr	
○	c. Seismic velocity (p/s in fps)		
●	2. Alluvial Fan Deposits (A_5; map area in nm^2)	185	37%
○	a. Thickness (max./min./avg. in ft.)		
◐	b. Lithology	Sand, silt, gr	
○	c. Seismic velocity (p/s in fps)		
●	3. Playa Deposits (A_4; map area in nm^2)	1	1%
○	a. Thickness (max./min./avg. in ft.)		
◐	b. Lithology	Sand, silt	
○	c. Seismic velocity (p/s in fps)		
)	4. Wind-blown Sand (A_3; map area in nm^2)	0	0
	a. Thickness (max./min./avg. in ft.)	N/A	
	b. Lithology	N/A	
	c. Seismic velocity (p/s in fps)	N/A	
●	5. Pediment Deposits (A_6; map area in nm^2)	8	1%
○	a. Thickness (max./min./avg. in ft.)		
◐	b. Lithology	Sand, gravel	
○	c. Seismic velocity (p/s in fps)		
●	6. Stream Channel and Floodplain Deposits (A_1; map area in nm^2)	28	5%
○	a. Thickness (max./min./avg. in ft.)		
◐	b. Lithology	Sand, gravel,	
○	c. Seismic velocity (p/s in fps)		

Quality of Data
- ● Data derived from detailed studies
- ◐ Estimated values
- ○ Insufficient data available

3132-A

DESCRIPTION			
2.2.3) in Basin-Fill Deposits m2)			
.)			
t.)			
city (p/s in fps)			
TS IN SITING VALLEY ted Deposits (A; map area	274	55%	
ax./min./avg. in ft.)			
	Sand, silt, gravel		
city (p/s in fps)			
Deposits (A_5; map area in nm^2)	185	37%	
ax./min./avg. in ft.)			
	Sand, silt, gravel		
ocity (p/s in fps)			
s (A_4; map area in nm^2)	1	1%	
max./min./avg. in ft.)			
	Sand, silt		
ocity (p/s in fps)			
nd (A_3; map area in nm^2)	0	0	
max./min./avg. in ft.)	N/A		
	N/A		
ocity (p/s in fps)	N/A		
osits (A_6; map area in nm^2)	8	1%	
max./min./avg. in ft.)			
	Sand, gravel		
ocity (p/s in fps)			
l and Floodplain Deposits in nm^2)	28	5%	
max./min./avg. in ft.)			
	Sand, gravel, silt		
locity (p/s in fps)			

studies

QUALITY OF DATA	DESCRIPTION		
●	7. Terrace Deposits (A_2; map area in nm^2)	0	0
	a. Thickness (max./min./avg. in ft.)	N/A	
	b. Lithology	N/A	
	c. Seismic velocity (p/s in fps)	N/A	
○	8. General Summary of Relationships		
	E. TECTONIC FRAMEWORK OF SITING VALLEY		
◒	1. Capable or Potentially Capable Fault	None	
	a. Total length (nm)	N/A	
	b. Relative location	N/A	
	c. Type of faulting, regional and local attitudes (strike and dip)	N/A	
	d. Minimum age of displacement or seismic activity (y.b.p.)	N/A	
●	2. Volcanism	None	
	a. Volcanic flows	N/A	
	1) Location and map area in nm^2	N/A	
	2) Minimum age of volcanic activity (y.b.p.)	N/A	
	F. SEISMICITY OF SITING VALLEY (Regional seismicity discussed in Section 2.2.4 of text)		
◒	1. Relative Pre-Instrumental Historic Activity (Section 2.2.4)	Low	
◒	2. Site Area Seismic Activity (instrumental, 1927-1973; Section 2.2.4)		
○	a. Events (epicenters) greater than M=6.0	None	
◒	b. Events (epicenters) greater than M=1.0 and less than M=6.0	M=4.1 in 196	
○	c. Events less than M=1.0 (includes microearthquakes)		
◒	3. Maximum Reported Modified Mercalli Intensity	VI	
◒	4. Source of Possible Ground Acceleration Levels (Section 2.2.4)	Salton Troug	
◒	a. Maximum credible level (g)	0.15	
◒	b. Most probable level (g)		
	G. Additional Remarks		

Quality of Data
- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

3/32-8

m2)	0	0	
	N/A		
	N/A		
	N/A		
lt	None		
	N/A		
	N/A		
attitudes	N/A		
lc activity	N/A		
	None		
	N/A		
	N/A		
	N/A		
seismicity Activity	Low		
mental,			
.0	None		
.0 and less	M=4.1 in 1964		
roearthquakes)			
Intensity	VI		
tion Levels	Salton Trough (Zone 1)	Transition Zone (Zone 2)	Diffuse Seismic ity (Zone 3)
	0.15	0.1	0.2
		0.05	

SOILS ENGINEERING PROPERTIES (1)	26
Unified soil classification (2)	(GM-SM)
AASHO soil classification	(A-1, A-2)
Percent Passing #4 sieve	
Percent passing #40 sieve	
Percent passing #200 sieve	
Liquid limit/plasticity index	
Surface consistency	
Dry density (pcf)	
Permeability (cm/sec)	
In-situ shear strength (psi)	
In-situ angle of internal friction (degrees)	
Cohesion (psi)	
Shrink-swell potential	
Coefficient of compressibility (in^2/lb.)	
In-situ CBR	
Recompacted CBR	
General surface moisture condition	
Compressional wave velocities (fps)	
Shear wave velocities (fps)	
Deleterious substances	Caliche present
ENGINEERING DESIGN EVALUATIONS (1)	
Suitability as impermeable membrane when recompacted	(Poor)
Suitability as source of sand/fill material	(Fair)/(Fair)
Suitability as source of aggregate/base course	(Fair)/(Fair)
Near surface foundation design characteristics	(High strength)
Fxcavation limitations and slope angle	(Difficult rip-ing or blasting

Explanation

	No literature available and data not extrapolated
(SP-SM)	No literature available and data extrapolated
SP-SM	Data available in literature

(1) Surface soils only, depth of less than 5 feet
(2) Related geologic unit(s) shown in Additional Remarks (e.g., Al_Q)

Additional Remarks

Highly cemented ($A5_T$)

3.13.3 Growl

MAP UNIT NUMBER					
26	27	28	29	31	33
(GM-SM)	GM-SM	GM, SM, ML	(GM-SM)	GM,SM,ML,CL	GM,SM,SP,ML,CI
(A-1, A-2)	A-1, A-2	A-1,A-2,or A-4	A-1, A-2	A-2, A-4 or A-6	A-2,A-4 or A-6
	35-80	40-95		45-100	45-100
	30-55	40-65		30-85	30-100
	15-35	25-50		20-75	50-100
	NP/NP	20-30/0-10		0-40/0-25	10-45/NP-30
	10^{-2} to 10^{-4}	10^{-1} to 10^{-3}		10^{-1} to 10^{-4}	10^{-2} to 10^{-4}
	Low	Low		Low to moderate	Low to moderat
Caliche present	Caliche present in some areas	Sulfate present in some areas			
(Poor)	Poor	Poor	(Poor)	Poor	Fair to Poor
(Fair)/(Fair)	Fair/Good	Poor/Fair	(Fair)/(Good)	Poor/Fair	Fair/Fair
(Fair)/(Fair)	Fair/Fair	Fair/Fair	(Fair)/(Fair)	Poor/Poor	Fair/Fair
(High strength)	Mod. strength Low comp.	Mod. strength	(Mod. strength)	Mod. strength Mod. expan.	Low strength Mod. comp.
(Difficult ripping or blasting)	Sloughing and/or difficult ripping	Sloughing 45°-60°	(Difficult ripping or blasting)	Ravelling 45°-60°	45°-60°
Highly cemented; ($A5_T$)	Highly alkaline; corrosive to uncoated steel; ($A5_{QT}$; $A5c_Q$)	Highly alkaline corrosive to uncoated steel; possible sulfate corrosion of concrete; ($A5_Q$)	Depth to rock less than 10 feet; ($A6_Q$)	(A_Q)	Subject to channel floodi ($A1_Q$)

	MAP UNIT NUMBER				
	28	29	31	33	34
	GM, SM, ML	(GM-SM)	GM,SM,ML,CL	GM,SM,SP,ML,CL	(ML-CL)
2	A-1,A-2,or A-4	A-1, A-2	A-2, A-4 or A-6	A-2,A-4 or A-6	(A-4 or A-6)
	40-95		45-100	45-100	
	40-65		30-85	30-100	A-4 or A-6
	25-50		20-75	50-100	
	20-30/0-10		0-40/0-25	10-45/NP-30	
10^{-4}	10^{-1} to 10^{-3}		10^{-1} to 10^{-4}	10^{-2} to 10^{-4}	
	Low		Low to moderate	Low to moderate	
present areas	Sulfate present in some areas				
	Poor	(Poor)	Poor	Fair to Poor	(Fair)
od	Poor/Fair	(Fair)/(Good)	Poor/Fair	Fair/Fair	NA/(Poor)
ir	Fair/Fair	(Fair)/(Fair)	Poor/Poor	Fair/Fair	NA/(Poor)
rength mp.	Mod. strength	(Mod. strength)	Mod. strength Mod. expan.	Low strength Mod. comp.	(Low strength) (Mod. comp.)
ng and/or lt ripping	Sloughing 45°-60°	(Difficult ripping or blasting)	Ravelling 45°-60°	45°-60°	($> 60^{\circ}$)
lkaline; ve to d steel; A5c$_Q$)	Highly alkaline corrosive to uncoated steel; possible sulfate corrosion of concrete; (A5$_Q$)	Depth to rock less than 10 feet; (A6$_Q$)	(A$_Q$)	Subject to channel flooding (A1$_Q$)	Subject to possible flooding (A4$_Q$)

QUALITY OF DATA	DESCRIPTION	
	A. SURFACE WATER IN SITING VALLEY	
●	1. Playas; Intermittent and Perennial Lakes	Unnam
○	a. Duration of surface water (wks.)	
◒	b. Maximum extent (nm^2)	0.5
○	c. Water depth (avg. in ft.)	
◒	d. Source of water	Direc
○	e. Water quality	
◒	2. Springs	None
	a. Duration of flow (wks.)	N/A
	b. Estimated maximum flow rate (gpm/season)	N/A
	c. Water quality	N/A
◒	3. Rivers or Streams	Danie
◒	a. Rate (gpm) and duration of flow (wks.)	Ephem
○	b. Water quality	
	B. HYDROLOGIC CHARACTERISTICS OF SITING VALLEY	
◒	1. Drainage Channel (PR=Primary; S=Secondary)	Danie
○	a. Depth of incision (max./min./avg.; ft.)	/
◒	b. Width (max./min./avg.; ft.)	1500/
◒	c. Gradient (ft./mi.)	30 to
◒	d. Channel bottom characteristics	Grave
◒	e. Channel cross-section (schematic)	
◒	f. Channel spacing (avg. in ft.)	Main
◒	g. Preliminary flood susceptibility rating (Section 2.4.1)	
○	2. Preliminary Flood Susceptibility Rating of Major Landform Surfaces (Section 2.4.1)	CF1
○	a. Undifferentiated deposits	
○	b. Alluvial fans	
○	c. Playas (active=a; mantled=m)	
○	d. Pediments	
○	e. Sand dunes	
○	f. Terraces (l=lake; r=river)	
	C. ADDITIONAL REMARKS	Obse inte

Quality of Data
- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

3.13.4 Growler

Lakes	Unnamed playa (west-central portion of Valley)			
	0.5			
	Direct precipitation and surface run-off			
	None			
	N/A			
on)	N/A			
	N/A			
	Daniels Arroyo	Growler Wash	San Cristobal Wash	Ten-Mile Wash
)	Ephemeral	Ephemeral	Ephemeral	Ephemeral
ALLEY ary)	Daniels Arroyo (PR)	Growler Wash (PR)	San Cristobal Wash (PR)	Ten-Mile Wash (PR)
.)	/ / 4 to 5			
	1500/50 est./	3000/75 est./	3000/100 est./	1500/75 est./
	30 to 40	20	20	10 to 20
	Gravel, sand	Gravel, sand	Gravel, sand	Gravel, sand
	Main channel	Main channel	Main channel	Main channel
ing				
ating of .4.1)	CF1	CF1	CF1	CF1

Observations are based mainly on a brief aerial reconnaissance and interpretation of topographic maps and aerial photographs.

ntral portion of Valley)

nd surface run-off

Growler Wash	San Cristobal Wash	Ten-Mile Wash	Numerous unnamed streams
Ephemeral	Ephemeral	Ephemeral	Ephemeral
Growler Wash (PR)	San Cristobal Wash (PR)	Ten-Mile Wash (PR)	Numerous unnamed washes (S)
3000/75 est./	3000/100 est./	1500/75 est./	
20	20	10 to 20	10 to 40
Gravel, sand	Gravel, sand	Gravel, sand	Gravel, sand
Main channel	Main channel	Main channel	
CF1	CF1	CF1	

mainly on a brief aerial reconnaissance and
graphic maps and aerial photographs.

QUALITY OF DATA	DESCRIPTION	
	A. DEPTH TO GROUNDWATER WITHIN BASIN-FILL MATERIAL IN SITING VALLEY (Map area in nm^2)	
○	1. 0 to 50 feet	
○	a. 0 to 25 feet	
○	b. 25 to 50 feet	
○	2. 50 to 100 feet	
◒	3. Greater than 100 feet	318
◒	4. Unknown or not Present	181
	B. AQUIFER CHARACTERISTICS IN VALLEY	
◒	1. Type of Aquifer (B=Basin Fill; P=Perched; R=Rock; u=unconfined; c=confined)	
○	a. Map area and extent	
◒	b. Depth to aquifer (ft.)	
○	c. Thickness (ft.)	
◒	d. Composition	Sand
○	e. Porosity (%)	
○	f. Specific yield (%)	
○	g. Transmissivity (ft.^{2}/day)	
○	h. Specific capacity (gpm/ft. of drawdown)	
○	i. Total pumpage (ac. ft./unit time)	
◒	j. Groundwater ownership rights	Luke
	C. WATER BUDGET FOR VALLEY	
○	1. Total Recharge (ac. ft./unit time)	
○	2. Total Discharge (ac. ft./unit time)	
	D. ADDITIONAL REMARKS	(a)

Quality of Data

- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

PTION			
HIN BASIN-FILL Y (Map area			
t	318	64%	Less than 200 to 500 feet
nt	181	36%	Unknown, but probably greater than 500, if present
IN VALLEY			
asin Fill; P=Perched; ; c=confined)	Bu		Ru See Additional Remarks (a)
t.)	460		12
	Sand and gravel		Granitic basement rock (Il_{PC})
/day)			
gpm/ft. of drawdown)			
ft./unit time)			
ip rights	Luke AFB		
ft./unit time)			
. ft./unit time)			
	(a) Rock aquifer is fracture system		

QUALITY OF DATA	DESCRIPTION		
	A. VALLEY AREA, OWNERSHIP AND LAND UTILIZATION		
●	1. Area of Valley	$385nm^2$	100%
●	a. Area of valley excluded by major cultural or quantity-distance exclusions and 10% grade exclusion	$63nm^2$	16%
●	2. Area of Siting Valley (A.1 minus A.1.a)	$322nm^2$	84%
●	3. Ownership	DoD, U.S. Air Forc	
●	a. Portion of siting valley with direct DoD ownership	$322nm^2$	100%
◒	b. Co-owners or administrators of co-use land/ constraints	Along north DoD bo on DoD property -	
◒	4. Contiguous BLM or Co-Use Land (area in nm^2)	175	BLM (Sent
◒	a. Relative location in or adjacent to valley	Adjacent to Valley	
○	b. Present use		
	B. CULTURAL AND QUANTITY-DISTANCE EXCLUSIONS		
●	1. Location of 18 nm Arc (population greater than 25,000)	None	
●	2. Location of 3 nm Arc (population greater than 5,000)	None	
●	3. Other	1780 foot exclusio	
	C. CULTURAL IMPROVEMENTS		
◒	1. Roads/Railroads (name)	U.S. 85	
◒	a. Relative location in valley	Transects Valley approximately nort	
◒	b. Type and use	Improved public hi	
●	2. Utilities (type)	Electrical transmi	
●	a. Relative location in valley	Parallel and adjac	
●	**D. MILITARY/GOVERNMENTAL USE AREAS**	North Tactical Ran	
●	1. Location and areal extent (nm^2)	West-central porti	
●	2. Present use	Air-to-ground targ	
○	3. Future use		
◒	4. Decontamination necessary prior to siting	Ordance present, h	
	E. ADDITIONAL REMARKS		

Quality of Data

● Data derived from detailed studies

◒ Estimated values

○ Insufficient data available

	$385nm^2$	100%	
	$63nm^2$	16%	
	$322nm^2$	84%	
	DoD, U.S. Air Force, Luke AFB		
	$322nm^2$	100%	
V	Along north DoD boundary, near Range #11, farmers have apparently encroached on DoD property - legal status unknown		
	175	BLM (Sentinel Plain)	
	Adjacent to Valley north of LWBGR boundary		
ter	None		
r	None		
	1780 foot exclusion corridor along U.S. 85		
	U.S. 85	Unnamed roads and jeep trails	Tucson, Cornelia and Gila Bend Railroad
	Transects Valley approximately north-south	Randomly transect Valley	Transects Valley approximately north-south
	Improved public highway	Improved and unimproved; military and restricted civilian	Private; unrestricted
	Electrical transmission lines		
	Parallel and adjacent to U.S. 85 and extending to Range #2		
	North Tactical Range West-central portion of Valley; approximately $60nm^2$		
	Air-to-ground target training conducted by Luke AFB		
ing	Ordance present, but type unknown		

QUALITY OF DATA	DESCRIPTION			
	A. TOPOGRAPHIC GRADIENT IN SITING VALLEY			
●	1. Area with Less than 10% Grade	322nm^2	100%	
●	2. Area with 5 to 10% Grade	4nm^2	1%	
●	3. Area with 0 to 5% Grade	318nm^2	99%	
●	4. Location of Alluvial Passes or Valley Boundaries Having Less than 10% Grade	Western portion contiguous Eastern portion contiguous		
	B. ROCK CONDITIONS IN SITING VALLEY (BR=Basement, B=Bedrock, VF=Volcanic Flows)			
◒	1. Exposed Rock (category/symbol/lithology)	B/I3$_{QT}$/basalt; VF/I2$_T$/ande		
◒	a. Location and map area in nm^2	27	8%	Along fl
◒	b. Seismic velocity (p/s in fps)			
●	c. Conditions of volcanic flow	Sentinel Basalt Flow: Fai hills, radial drainage of		
◒	2. Pediments (rock type)			
◒	a. Location and map area in nm^2	5	2%	Along fl
◒	b. Exposure condition	Thin to non-existent mantl		
◒	c. Distance into siting valley from rock exposures (max./min./avg.) (nm)	7/0.5/3.5		
	C. SUBSURFACE ROCK CONDITIONS IN SITING VALLEY (BR=Basement, B=Bedrock, VF=Volcanic Flows)			
	1. Depth to Rock (map area in nm^2)			
◒	a. 0 to 250 feet (excluding pediments)	92	28%	
◒	1) Type	BR, B, VF		
○	2) Seismic velocity (p/s in fps)			
○	b. 250 to 500 feet			
○	1) Type			
○	2) Seismic velocity (p/s in fps)			
○	c. 500 to 1000 feet			
○	1) Type			
○	2) Seismic velocity (p/s in fps)			
○	d. Greater than 1000 feet			
○	1) Type			
○	2) Seismic velocity (p/s in fps)			
◒	e. Unknown	198	62%	Greater (

Quality of Data

● Data derived from detailed studies

◒ Estimated values

○ Insufficient data available

$322nm^2$	100%	
$4nm^2$	1%	
$318nm^2$	99%	

Western portion contiguous with Growler-Childs Valley across Valley boundary
Eastern portion contiguous with Gila Bend Plain across Valley boundary

B/I3$_{QT}$/basalt; VF/I2$_T$/andesitic to basaltic volcanics

27	8%	Along flanks of Crater Range and Sauceda Mountains, within Sentinel Flow, $24nm^2$

Sentinel Basalt Flow: Fairly smooth, low topography with scattered low relief hills, radial drainage of basin-fill deposits, may have thin mantle (10%).

5	2%	Along flanks of Sauceda Mountains

Thin to non-existent mantle of pediment deposits

7/0.5/3.5

92	28%	

BR, B, VF

198	62%	Greater than 250 feet, maximum depth unknown

QUALITY OF DATA	DESCRIPTION		
○	2. Rock (Section 2.2.3) in Basin-Fill Deposits (map area in nm^2)		
○	a. Type		
○	b. Depth to (ft.)		
○	c. Thickness (ft.)		
○	d. Seismic velocity (p/s in fps)		
	D. BASIN-FILL DEPOSITS IN SITING VALLEY		
●	1. Undifferentiated Deposits (A; map area in nm^2)	132	4
○	a. Thickness (max./min./avg. in ft.)		
◒	b. Lithology	Sand, silt,	
○	c. Seismic velocity (p/s in fps)		
●	2. Alluvial Fan Deposits (A_5; map area in nm^2)	153	4
○	a. Thickness (max./min./avg. in ft.)		
◒	b. Lithology	Sand, silt,	
○	c. Seismic velocity (p/s in fps)		
●	3. Playa Deposits (A_4; map area in nm^2)	0	
	a. Thickness (max./min./avg. in ft.)	N/A	
	b. Lithology	N/A	
	c. Seismic velocity (p/s in fps)	N/A	
●	4. Wind-blown Sand (A_3; map area in nm^2)	0	
	a. Thickness (max./min./avg. in ft.)	N/A	
	b. Lithology	N/A	
	c. Seismic velocity (p/s in fps)	N/A	
●	5. Pediment Deposits (A_6; map area in nm^2)	5	
○	a. Thickness (max./min./avg. in ft.)		
◒	b. Lithology	Sand, grav	
○	c. Seismic velocity (p/s in fps)		
●	6. Stream Channel and Floodplain Deposits (A_1; map area in nm^2)	5	
○	a. Thickness (max./min./avg. in ft.)		
◒	b. Lithology	Sand, silt,	
○	c. Seismic velocity (p/s in fps)		

Quality of Data

- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

3142-A

DESCRIPTION			
n 2.2.3) in Basin-Fill Deposits nm^2)			
ft.)			
(ft.)			
locity (p/s in fps)			
ITS IN SITING VALLEY			
lated Deposits (A; map area	132	41%	
(max./min./avg. in ft.)			
	Sand, silt, gravel		
locity (p/s in fps)			
n Deposits (A_5; map area in nm^2)	153	47%	
(max./min./avg. in ft.)			
	Sand, silt, gravel		
elocity (p/s in fps)			
its (A_4; map area in nm^2)	0	0	
(max./min./avg. in ft.)	N/A		
	N/A		
elocity (p/s in fps)	N/A		
Sand (A_3; map area in nm^2)	0	0	
(max./min./avg. in ft.)	N/A		
	N/A		
elocity (p/s in fps)	N/A		
posits (A_6; map area in nm^2)	5	2%	
(max./min./avg. in ft.)			
	Sand, gravel		
elocity (p/s in fps)			
nnel and Floodplain Deposits rea in nm^2)	5	2%	
(max./min./avg. in ft.)			
	Sand, silt, gravel		
velocity (p/s in fps)			

led studies

able

QUALITY OF DATA	DESCRIPTION	
●	7. Terrace Deposits (A_2; map area in nm^2)	0
○	a. Thickness (max./min./avg. in ft.)	N/A
○	b. Lithology	N/A
○	c. Seismic velocity (p/s in fps)	N/A
○	8. General Summary of Relationships	
	E. TECTONIC FRAMEWORK OF SITING VALLEY	
◒	1. Capable or Potentially Capable Fault	None
	a. Total length (nm)	N/A
	b. Relative location	N/A
	c. Type of faulting, regional and local attitudes (strike and dip)	N/A
	d. Minimum age of displacement or seismic activity (y.b.p.)	N/A
●	2. Volcanism	
●	a. Volcanic flows	Sentinel
●	1) Location and map area in nm^2	Along nc
●	2) Minimum age of volcanic activity (y.b.p.)	1.7 mill
	F. SEISMICITY OF SITING VALLEY (Regional seismicity discussed in Section 2.2.4 of text)	
◒	1. Relative Pre-Instrumental Historic Activity (Section 2.2.4)	None
◒	2. Site Area Seismic Activity (instrumental, 1927-1973; Section 2.2.4)	
◒	a. Events (epicenters) greater than M=6.0	None
◒	b. Events (epicenters) greater than M=1.0 and less than M=6.0	None
○	c. Events less than M=1.0 (includes microearthquakes)	
◒	3. Maximum Reported Modified Mercalli Intensity	V to VI
◒	4. Source of Possible Ground Acceleration Levels (Section 2.2.4)	Salton
◒	a. Maximum credible level (g)	0.12
◒	b. Most probable level (g)	
	G. Additional Remarks	

Quality of Data
- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

3142-B

O N			
in nm^2)	0	0	
	N/A		
	N/A		
	N/A		
s			
Fault	None		
	N/A		
	N/A		
ocal attitudes	N/A		
ismic activity	N/A		
	Sentinel Flow		
	Along northern portion of Valley; approximately 25		
ity	1.7 million		
al seismicity ric Activity	None		
trumental,			
M=6.0	None		
M=1.0 and less	None		
microearthquakes)			
lli Intensity	V to VI (?)		
eration Levels	Salton Trough (Zone 1)	Transition Zone (Zone 2)	Diffuse Seismicity (Zone 3)
	0.12	0.1	0.2
		0.01	

SOILS ENGINEERING PROPERTIES(1)	27	2
Unified soil classification (2)	GM-SM	GM, SM,
AASHO soil classification	A-1,A-2	A-1,A-
Percent passing #4 sieve	35-80	40-95
Percent passing #40 sieve	30-55	40-65
Percent passing #200 sieve	15-35	25-50
Liquid limit/plasticity index	NP/NP	20-30/
Surface consistency		
Dry density (pcf)		
Permeability (cm/sec)	10^{-2} to 10^{-4}	10^{-1} t
In-situ shear strength (psi)		
In-situ angle of internal friction (degrees)		
Cohesion (psi)		
Shrink-swell potential	Low	Low
Coefficient of compressibility (in^2/lb.)		
In-situ CBR		
Recompacted CBR		
General surface moisture condition		
Compressional wave velocities (fps)		
Shear wave velocities (fps)		
Deleterious substances	Caliche present in some areas	Sulfat in som
ENGINEERING DESIGN EVALUATIONS(1)		
Suitability as impermeable membrane when recompacted	Poor	Poor
Suitability as source of sand/fill material	Fair/Good	Poor/F
Suitability as source of aggregate/base course	Fair/Fair	Fair/F
Near surface foundation design characteristics	Mod. strength Low comp.	Mod. s
Excavation limitations and slope angle	Sloughing and/or difficult ripping	Slough 45^{o}-6
Additional Remarks	Highly alkaline; corrosive to uncoated steel; ($A5_{QT}$; $A5c_{Q}$)	Highly corro uncoat possi corro concr ($A5_{Q}$)

Explanation

(blank box)	No literature available and data not extrapolated
(SP-SM)	No literature available and data extrapolated
SP-SM	Data available in literature

(1) Surface soils only, depth of less than 5 feet

(2) Related geologic unit(s) shown in Additional Remarks (e.g., $A1_{Q}$)

	MAP UNIT NUMBER				
	27	28	29	31	33
	GM-SM	GM, SM, ML	(GM-SM)	GM,SM,ML,CL	GM,SM, ,ML,CL
	A-1,A-2	A-1,A-2 or A-4	(A-1, A-2)	A-2,A-4, or A-6	A-2,A-4,A-6 or A-7
	35-80	40-95		45-100	45-100
	30-55	40-65		50-85	30-100
	15-35	25-50		20-75	50-100
	NP/NP	20-30/0-10		0-40/0-25	10-45/NP-30
	10^{-2} to 10^{-4}	10^{-1} to 10^{-3}		10^{-1} to 10^{-4}	10^{-2} to 10^{-4}
	Low	Low		Low to moderate	Low to moderate
	Caliche present in some areas	Sulfates present in some areas			
ted	Poor	Poor	(Poor)	Poor	Fair to Poor
	Fair/Good	Poor/Fair	(Fair)/(Good)	Poor/Fair	Fair/Fair
	Fair/Fair	Fair/Fair	(Fair)/(Fair)	Poor/Poor	Fair/Fair
	Mod. strength Low comp.	Mod. strength	(Mod. strength)	Mod. strength Mod. expan.	Low strength Mod. comp.
	Sloughing and/or difficult ripping	Sloughing 45°-60°	(Difficult ripping or blasting)	Ravelling 45°-60°	45°-60°
xtrapolated polated han 5 feet Additional — Additional Remarks	Highly alkaline; corrosive to uncoated steel; ($A5_{QT}$; $A5c_Q$)	Highly alkaline; corrosive to uncoated steel; possible sulfate corrosion of concrete; ($A5_Q$)	Depth to rock less than 10 feet; ($A6_Q$)	(A_Q)	Subject to flooding; ($A1_Q$)

QUALITY OF DATA	DESCRIPTION	
	A. SURFACE WATER IN SITING VALLEY	
●	1. Playas; Intermittent and Perennial Lakes	None
	a. Duration of surface water (wks.)	N/A
	b. Maximum extent (nm^2)	N/A
	c. Water depth (avg. in ft.)	N/A
	d. Source of water	N/A
	e. Water quality	N/A
◒	2. Springs	None
	a. Duration of flow (wks.)	N/A
	b. Estimated maximum flow rate (gpm/season)	N/A
	c. Water quality	N/A
◒	3. Rivers or Streams	Midway Wash
◒	a. Rate (gpm) and duration of flow (wks.)	Ephemeral
○	b. Water quality	
	B. HYDROLOGIC CHARACTERISTICS OF SITING VALLEY	
◒	1. Drainage Channel (PR=Primary; S=Secondary)	Midway Wash (PR)
○	a. Depth of incision (max./min./avg.; ft.)	
◒	b. Width (max./min./avg.; ft.)	1500/50 est./
◒	c. Gradient (ft./mi.)	20
◒	d. Channel bottom characteristics	Gravel, sand
◒	e. Channel cross-section (schematic)	
○	f. Channel spacing (avg. in ft.)	
◒	g. Preliminary flood susceptibility rating (Section 2.4.1)	CF1
○	2. Preliminary Flood Susceptibility Rating of Major Landform Surfaces (Section 2.4.1)	
○	a. Undifferentiated deposits	
○	b. Alluvial fans	
○	c. Playas (active=a; mantled=m)	
○	d. Pediments	
○	e. Sand dunes	
○	f. Terraces (l=lake; r=river)	
	C. ADDITIONAL REMARKS	Observations are b interpretation of

Quality of Data
- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

N			
nnial Lakes	None		
)	N/A		
	N/A		
	N/A		
	N/A		
	N/A		
	None		
	N/A		
m/season)	N/A		
	N/A		
	Midway Wash	Ten-Mile Wash	Numerous unnamed streams
(wks.)	Ephemeral	Ephemeral	Ephemeral
ING VALLEY Secondary)	Midway Wash (PR)	Ten-Mile Wash (PR)	Numerous unnamed washes (PR and S)
vg.; ft.)			
	1500/50 est./	1500/75 est./	
	20	10 to 15	10 to 30
	Gravel, sand	Gravel, sand	Gravel, sand
ic)			
ty rating	CF1	CF1	
ity Rating of ion 2.4.1)			
	Observations are based mainly on a brief aerial reconnaissance and interpretation of topographic maps and aerial photographs.		

QUALITY OF DATA	DESCRIPTION		
	A. DEPTH TO GROUNDWATER WITHIN BASIN-FILL MATERIAL IN SITING VALLEY (Map area in nm^2)		
○	1. 0 to 50 feet		
○	a. 0 to 25 feet		
○	b. 25 to 50 feet		
○	2. 50 to 100 feet		
◒	3. Greater than 100 feet	275	85%
◒	4. Unknown or not Present	47	15%
	B. AQUIFER CHARACTERISTICS IN VALLEY		
◒	1. Type of Aquifer (B=Basin Fill; P=Perched; R=Rock; u=unconfined; c=confined)	Bu	
○	a. Map area and extent		
◒	b. Depth to aquifer (ft.)	408	
○	c. Thickness (ft.)		
◒	d. Composition	Sand and gravel	
○	e. Porosity (%)		
○	f. Specific yield (%)		
○	g. Transmissivity ($ft.^2$/day)		
○	h. Specific capacity (gpm/ft. of drawdown)		
○	i. Total pumpage (ac. ft./unit time)		
◒	j. Groundwater ownership rights	Luke AFB	
	C. WATER BUDGET FOR VALLEY		
○	1. Total Recharge (ac. ft./unit time)		
○	2. Total Discharge (ac. ft./unit time)		
	D. ADDITIONAL REMARKS		

Quality of Data
- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

N			
IN-FILL rea			
	275	85%	Less than 200 to 600 feet
	47	15%	Unknown, but probably greater than 600 feet, if present
EY ll; P=Perched; fined)	Bu		
	408		
	Sand and gravel		
f drawdown)			
time)			
	Luke AFB		
it time)			
nit time)			

QUALITY OF DATA	DESCRIPTION	
	A. VALLEY AREA, OWNERSHIP AND LAND UTILIZATION	
●	1. Area of Valley	$321nm^2$
●	a. Area of valley excluded by major cultural or quantity-distance exclusions and 10% grade exclusion	$127nm^2$
●	2. Area of Siting Valley (A.1 minus A.1.a)	$194nm^2$
●	3. Ownership	DoD, U
●	a. Portion of siting valley with direct DoD ownership	$194nm^2$
●	b. Co-owners or administrators of co-use land/ constraints	None
◒	4. Contiguous BLM or Co-Use Land (area in nm^2)	200
◒	a. Relative location in or adjacent to valley	Adjac
○	b. Present use	
	B. CULTURAL AND QUANTITY-DISTANCE EXCLUSIONS	
●	1. Location of 18 nm Arc (population greater than 25,000)	None
●	2. Location of 3 nm Arc (population greater than 5,000)	None
●	3. Other	1780
	C. CULTURAL IMPROVEMENTS	
◒	1. Roads/Railroads (name)	U.S.
◒	a. Relative location in valley	Tran of Va
◒	b. Type and use	Impro
●	2. Utilities (type)	Elect
●	a. Relative location in valley	Adjac
	D. MILITARY/GOVERNMENTAL USE AREAS	Gila Nort appro Prov supp
●	1. Location and areal extent (nm^2)	
●	2. Present use	
○	3. Future use	
◒	4. Decontamination necessary prior to siting	
	E. ADDITIONAL REMARKS	

Quality of Data

- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

OWNERSHIP AND CU
3.15.1 Gila Ben

ON			
	$321nm^2$	100%	
1	$127nm^2$	40%	
,a)	$194nm^2$	60%	
	DoD, U.S. Air Force, Luke AFB		
	$194nm^2$	100%	
and/	None		
	200	BLM	
ley	Adjacent to Valley north of LWBGR boundary		
S			
eater	None		
ter	None		
	1780 foot exclusion corridor along U.S. 85		
	U.S. 85	Unnamed roads and jeep trails	Tucson, Cornelia and G
	Transects northwest portion of Valley; approximately north-south	Randomly transect Valley	Transects northwest po approximately northeas
	Improved; public highway	Improved and unimproved; military and restricted civilian	Private; unrestricted
	Electrical transmission line		
	Adjacent to U.S. 85 and at Gila Bend Auxiliary Field		
	Gila Bend Auxiliary Field	East Tactical Range	
	Northwest end of Valley; approximately $1.5nm^2$	Central portion of Valley; approximately $200nm^2$	
	Provides facilities and combat support for Luke AFB	Air-to-ground target training conducted by Luke AFB	
ting		Ordance present, but type unknown	

OWNERSHIP AND CULTURAL FEATURES
3.15.1 Gila Bend Plain (LWBGR)

Luke AFB		
rth of LWBGR boundary		
orridor along U.S. 85		
	Unnamed roads and jeep trails	Tucson, Cornelia and Gila Bend Railroad
ortion ely north-south	Randomly transect Valley	Transects northwest portion of Valley; approximately northeast-southwest
ay	Improved and unimproved; military and restricted civilian	Private; unrestricted
on line		
nd at Gila Bend Auxiliary Field		
ield ey;	East Tactical Range Central portion of Valley; approximately $200nm^2$	
nd combat	Air-to-ground target training conducted by Luke AFB	
	Ordance present, but type unknown	

QUALITY OF DATA	DESCRIPTION		
	A. TOPOGRAPHIC GRADIENT IN SITING VALLEY		
●	1. Area with Less than 10% Grade	194nm^2	100%
●	2. Area with 5 to 10% Grade	2nm^2	1%
●	3. Area with 0 to 5% Grade	192nm^2	99%
●	4. Location of Alluvial Passes or Valley Boundaries Having Less than 10% Grade	Western porti	
	B. ROCK CONDITIONS IN SITING VALLEY (BR=Basement, B=Bedrock, VF=Volcanic Flows)		
◒	1. Exposed Rock (category/symbol/lithology)	BR/M_{MP}/gneiss	
◒	a. Location and map area in nm^2	10	5%
○	b. Seismic velocity (p/s in fps)		
	c. Conditions of volcanic flow	N/A	
◒	2. Pediments (rock type)		
◒	a. Location and map area in nm^2	31	16%
◒	b. Exposure condition	Thin to non-e	
◒	c. Distance into siting valley from rock exposures (max./min./avg.) (nm)	7/0.5/4	
	C. SUBSURFACE ROCK CONDITIONS IN SITING VALLEY (BR=Basement, B=Bedrock, VF=Volcanic Flows)		
	1. Depth to Rock (map area in nm^2)		
◒	a. 0 to 250 feet (excluding pediments)	58	30%
◒	1) Type	BR, B, VF	
○	2) Seismic velocity (p/s in fps)		
○	b. 250 to 500 feet		
○	1) Type		
○	2) Seismic velocity (p/s in fps)		
○	c. 500 to 1000 feet		
○	1) Type		
○	2) Seismic velocity (p/s in fps)		
○	d. Greater than 1000 feet		
○	1) Type		
○	2) Seismic velocity (p/s in fps)		
◒	e. Unknown	95	49%

Quality of Data

● Data derived from detailed studies

◒ Estimated values

○ Insufficient data available

O N			
LEY	$194nm^2$	100%	
	$2nm^2$	1%	
	$192nm^2$	99%	
Valley Grade	Western portion contiguous with Sentinel Plain across Valley boundary.		
ic Flows) ithology)	BR/M_{MP}/gneiss, schist		
	10	5%	Along flanks of Sauceda and Sand Tank Mountains
	N/A		
	31	16%	Along flanks of Sauceda and Sand Tank Mountains
	Thin to non-existent mantle of pediment deposits		
rock)	7/0.5/4		
NG VALLEY ic Flows))			
ts)	58	30%	
	BR, B, VF		
)			
)			
)			
)			
	95	49%	Greater than 250 feet, maximum depth unknown

- 4

QUALITY OF DATA	DESCRIPTION	
◒	2. Rock (Section 2.2.3) in Basin-Fill Deposits (map area in nm^2)	
◒	a. Type	Basalt (I3
◒	b. Depth to (ft.)	632
◒	c. Thickness (ft.)	Greater th
○	d. Seismic velocity (p/s in fps)	
	D. BASIN-FILL DEPOSITS IN SITING VALLEY	
●	1. Undifferentiated Deposits (A; map area in nm^2)	6
○	a. Thickness (max./min./avg. in ft.)	
◒	b. Lithology	Sand, silt
○	c. Seismic velocity (p/s in fps)	
●	2. Alluvial Fan Deposits (A_5; map area in nm^2)	143
○	a. Thickness (max./min./avg. in ft.)	
◒	b. Lithology	Sand, sil
○	c. Seismic velocity (p/s in fps)	
●	3. Playa Deposits (A_4; map area in nm^2)	0
	a. Thickness (max./min./avg. in ft.)	N/A
	b. Lithology	N/A
	c. Seismic velocity (p/s in fps)	N/A
●	4. Wind-blown Sand (A_3; map area in nm^2)	0
	a. Thickness (max./min./avg. in ft.)	N/A
	b. Lithology	N/A
	c. Seismic velocity (p/s in fps)	N/A
●	5. Pediment Deposits (A_6; map area in nm^2)	30
○	a. Thickness (max./min./avg. in ft.)	
◒	b. Lithology	Sand, si
○	c. Seismic velocity (p/s in fps)	
●	6. Stream Channel and Floodplain Deposits (A_1; map area in nm^2)	5
○	a. Thickness (max./min./avg. in ft.)	
◒	b. Lithology	Sand, si
○	c. Seismic velocity (p/s in fps)	

Quality of Data
- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

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D E S C R I P T I O N			
2.2.3) in Basin-Fill Deposits nm2)			
	Basalt ($I3_{QT}$)		
t.)	632		
ft.)	Greater than 14		
ocity (p/s in fps)			
ITS IN SITING VALLEY ated Deposits (A; map area	6	3%	
max./min./avg. in ft.)			
	Sand, silt, gravel		
locity (p/s in fps)			
Deposits (A_5; map area in nm^2)	143	74%	
(max./min./avg. in ft.)			
	Sand, silt, gravel; may be calichified		
locity (p/s in fps)			
its (A_4; map area in nm^2)	0	0	
(max./min./avg. in ft.)	N/A		
	N/A		
locity (p/s in fps)	N/A		
Sand (A_3; map area in nm^2)	0	0	
(max./min./avg. in ft.)	N/A		
	N/A		
locity (p/s in fps)	N/A		
posits (A_6; map area in nm^2)	30	15%	
(max./min./avg. in ft.)			
	Sand, silt, gravel		
locity (p/s in fps)			
nel and Floodplain Deposits ea in nm^2)	5	3%	
(max./min./avg. in ft.)			
	Sand, silt, gravel		
velocity (p/s in fps)			

ed studies

ble

●	7. Terrace Deposits (A_2; map area in nm^2)	0
	a. Thickness (max./min./avg. in ft.)	N/A
	b. Lithology	N/A
	c. Seismic velocity (p/s in fps)	N/A
○	8. General Summary of Relationships	
	E. TECTONIC FRAMEWORK OF SITING VALLEY	
◒	1. Capable or Potentially Capable Fault	None
	a. Total length (nm)	N/A
	b. Relative location	N/A
	c. Type of faulting, regional and local attitudes (strike and dip)	N/A
	d. Minimum age of displacement or seismic activity (y.b.p.)	N/A
●	2. Volcanism	None
	a. Volcanic flows	N/A
	1) Location and map area in nm^2	N/A
	2) Minimum age of volcanic activity (y.b.p.)	N/A
	F. SEISMICITY OF SITING VALLEY (Regional seismicity discussed in Section 2.2.4 of text)	
◒	1. Relative Pre-Instrumental Historic Activity (Section 2.2.4)	None
◒	2. Site Area Seismic Activity (instrumental, 1927-1973; Section 2.2.4)	
	a. Events (epicenters) greater than M=6.0	None
	b. Events (epicenters) greater than M=1.0 and less than M=6.0	None
	c. Events less than M=1.0 (includes microearthquakes)	
◒	3. Maximum Reported Modified Mercalli Intensity	V to VI (
◒	4. Source of Possible Ground Acceleration Levels (Section 2.2.4)	Salton Tr
◒	a. Maximum credible level (g)	0.1
◒	b. Most probable level (g)	
	G. Additional Remarks	

Quality of Data
- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

D N			
n nm2)	0	0	
	N/A		
	N/A		
	N/A		
'ault	None		
	N/A		
	N/A		
cal attitudes	N/A		
ismic activity	N/A		
	None		
	N/A		
	N/A		
ity	N/A		
al seismicity ric Activity	None		
trumental,			
M=6.0	None		
M=1.0 and less	None		
microearthquakes)			
lli Intensity	V to VI (?)		
eration Levels	Salton Trough (Zone 1)	Transition Zone (Zone 2)	Diffuse Seismicity (Zone 3)
	0.1	0.15	0.2
		0.05	

SOILS ENGINEERING PROPERTIES[1]	26	27
Unified soil classification [2]	(GM-SM)	GM-SM
AASHO soil classification	(A-1, A-2)	A-1, A-2
Percent passing #4 sieve		35-80
Percent passing #40 sieve		30-55
Percent passing #200 sieve		15-35
Liquid limit/plasticity index		NP/NP
Surface consistency		
Dry density (pcf)		
Permeability (cm/sec)		10^{-2} to 10^{-4}
In-situ shear strength (psi)		
In-situ angle of internal friction (degrees)		
Cohesion (psi)		
Shrink-swell potential		Low
Coefficient of compressibility (in^2/lb.)		
In-situ CBR		
Recompacted CBR		
General surface moisture condition		
Compressional wave velocities (fps)		
Shear wave velocities (fps)		
Deleterious substances	Caliche present	Caliche prese in some areas
ENGINEERING DESIGN EVALUATIONS[1]		
Suitability as impermeable membrane when recompacted	(Poor)	Poor
Suitability as source of sand/fill material	(Fair)/(Fair)	Fair/Good
Suitability as source of aggregate/base course	(Fair)/(Fair)	Fair/Fair
Near surface foundation design characteristics	(High strength)	Mod. strength Low comp.
Excavation limitations and slope angle	(Difficult ripping or blasting)	Sloughing and difficult rip
Additional Remarks	Highly cemented; ($A5_T$)	Highly alkali corrosive to uncoated ste ($A5_{QT}$; $A5c_Q$)

Explanation

(blank box)	No literature available and data not extrapolated
(SP-SM)	No literature available and data extrapolated
SP-SM	Data available in literature

(1) Surface soils only, depth of less than 5 feet

(2) Related geologic unit(s) shown in Additional Remarks (e.g. Al_Q)

MAP UNIT NUMBER					
26	27	28	29	31	33
)	GM-SM	GM,SM,ML	(GM-SM)	GM,SM,ML,CL	GM,SM,SP,ML,CL
A-2)	A-1, A-2	A-1,A-2 or A-4	(A-1, A-2)	A-2,A-4 or A-6	A-2,A-4,A-6,A-7
	35-80	40-95		45-100	45-100
	30-55	40-65		30-85	30-100
	15-35	25-50		20-75	50-100
	NP/NP	20-30/0-10		0-40/0-25	10-45/NP-30
	10^{-2} to 10^{-4}	10^{-1} to 10^{-3}		10^{-1} to 10^{-4}	10^{-2} to 10^{-4}
	Low	Low		Low to moderate	Low to moderate
he present	Caliche present in some areas	Sulfates present in some areas			
r)	Poor	Poor	(Poor)	Poor	Fair to Poor
r)/(Fair)	Fair/Good	Poor/Fair	(Fair)/(Good)	Poor/Fair	Fair/Fair
r)/(Fair)	Fair/Fair	Fair/Fair	(Fair)/(Fair)	Poor/Poor	Fair/Fair
strength)	Mod. strength Low comp.	Mod. strength	Mod. strength	Mod. strength Mod. e pan.	Low strength Mod. comp.
icult rip- or blasting)	Sloughing and/or difficult ripping	Sloughing 45°-60°	(Difficult ripping or blasting)	Ravelling 45°-60°	45°-60°
ly cemented;)	Highly alkaline; corrosive to uncoated steel; ($A5_{QT}$; $A5c_Q$)	Highly alkaline; corrosive to uncoated steel; possible sulfate corrosion of concrete; ($A5_Q$)	Depth to rock less than 10 feet; ($A6_Q$)	(A_Q)	Subject to flooding; ($A1_Q$)

QUALITY OF DATA	DESCRIPTION	
	A. SURFACE WATER IN SITING VALLEY	
●	1. Playas; Intermittent and Perennial Lakes	None
	a. Duration of surface water (wks.)	N/A
	b. Maximum extent (nm^2)	N/A
	c. Water depth (avg. in ft.)	N/A
	d. Source of water	N/A
	e. Water quality	N/A
◐	2. Springs	None
	a. Duration of flow (wks.)	N/A
	b. Estimated maximum flow rate (gpm/season)	N/A
	c. Water quality	N/A
◐	3. Rivers or Streams	Quilotosa Wash
◐	a. Rate (gpm) and duration of flow (wks.)	Ephemeral
○	b. Water quality	
	B. HYDROLOGIC CHARACTERISTICS OF SITING VALLEY	
◐	1. Drainage Channel (PR=Primary; S=Secondary)	Quilotosa Wash
◐	a. Depth of incision (max./min./avg.; ft.)	/ / 5 to 7
◐	b. Width (max./min./avg.; ft.)	/50'est./200
◐	c. Gradient (ft./mi.)	40
◐	d. Channel bottom characteristics	Gravel, sand, c
◐	e. Channel cross-section (schematic)	
○	f. Channel spacing (avg. in ft.)	
◐	g. Preliminary flood susceptibility rating (Section 2.4.1)	CF1
○	2. Preliminary Flood Susceptibility Rating of Major Landform Surfaces (Section 2.4.1)	
○	a. Undifferentiated deposits	
○	b. Alluvial fans	
○	c. Playas (active=a; mantled=m)	
○	d. Pediments	
○	e. Sand dunes	
○	f. Terraces (l=lake; r=river)	
	C. ADDITIONAL REMARKS	Observations a interpretation

Quality of Data

● Data derived from detailed studies
◐ Estimated values
○ Insufficient data available

ial Lakes	None		
	N/A		
	N/A		
	N/A		
	N/A		
	N/A		
	None		
	N/A		
'season)	N/A		
	N/A		
	Quilotosa Wash	Sauceda Wash	Numerous unnamed streams
wks.)	Ephemeral	Ephemeral	Ephemeral
G VALLEY condary)	Quilotosa Wash (PR)	Sauceda Wash (PR)	Numerous unnamed washes (S)
; ft.)	/ / 5 to 7	/ / 5 to 7	
	/50'est./200 to 300	/50 est./200 to 300	
	40	40	40 to 50
	Gravel, sand, cobbles	Gravel, sand, cobbles	Gravel, sand, cobbles
)			
rating	CF1	CF1	
y Rating of on 2.4.1)			
	Observations are based mainly on a brief aerial reconnaissance and interpretation of topographic maps and aerial photographs.		

QUALITY OF DATA	DESCRIPTION		
	A. DEPTH TO GROUNDWATER WITHIN BASIN-FILL MATERIAL IN SITING VALLEY (Map area in nm^2)		
○	1. 0 to 50 feet		
○	a. 0 to 25 feet		
○	b. 25 to 50 feet		
○	2. 50 to 100 feet		
◒	3. Greater than 100 feet	55	28%
◒	4. Unknown or not Present	139	72%
	B. AQUIFER CHARACTERISTICS IN VALLEY		
◒	1. Type of Aquifer (B=Basin Fill; P=Perched; R=Rock; u=unconfined; c=confined)		Bu
○	a. Map area and extent		
◒	b. Depth to aquifer (ft.)	255 (minimum)	
◒	c. Thickness (ft.)	30 (minimum)	
◒	d. Composition	Sand and gravel	
○	e. Porosity (%)		
○	f. Specific yield (%)		
○	g. Transmissivity ($ft.^2$/day)		
○	h. Specific capacity (gpm/ft. of drawdown)		
○	i. Total pumpage (ac. ft./unit time)		
◒	j. Groundwater ownership rights	Luke AFB; Gila Be	
	C. WATER BUDGET FOR VALLEY		
○	1. Total Recharge (ac. ft./unit time)		
○	2. Total Discharge (ac. ft./unit time)		
	D. ADDITIONAL REMARKS	(a) Rock aquifer	

Quality of Data
- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

L			
	55	28%	Less than 300 to 400 feet
	139	72%	Unknown, but probably greater than 400 feet if present

Perched;	Bu	Ru See Additional Remarks (a)
	255 (minimum)	60
	30 (minimum)	
	Sand and gravel	Granitic basement rock (Il_{PC})
own)		
	Luke AFB; Gila Bend AFAF	
)		
e)		
	(a) Rock aquifer is fracture system	

QUALITY OF DATA	DESCRIPTION		
	A. VALLEY AREA, OWNERSHIP AND LAND UTILIZATION		
●	1. Area of Valley	71nm^2	100%
●	a. Area of valley excluded by major cultural or quantity-distance exclusions and 10% grade exclusion	48nm^2	68%
●	2. Area of Siting Valley (A.1 minus A.1.a)	23nm^2	32%
●	3. Ownership	DoD, U.S. Air Force,	
●	a. Portion of siting valley with direct DoD ownership	23nm^2	100%
●	b. Co-owners or administrators of co-use land/ constraints	None	
◒	4. Contiguous BLM or Co-Use Land (area in nm^2)	175	BLM (Vekol
◒	a. Relative location in or adjacent to valley	Adjacent to Valley n	
○	b. Present use		
	B. CULTURAL AND QUANTITY-DISTANCE EXCLUSIONS		
●	1. Location of 18 nm Arc (population greater than 25,000)	None	
●	2. Location of 3 nm Arc (population greater than 5,000)	None	
●	3. Other	None	
	C. CULTURAL IMPROVEMENTS		
◒	1. Roads/Railroads (name)	Unnamed roads and je	
◒	a. Relative location in valley	Randomly transect Va	
◒	b. Type and use	Unimproved; military	
◒	2. Utilities (type)	None	
	a. Relative location in valley	N/A	
●	D. MILITARY/GOVERNMENTAL USE AREAS	None	
	1. Location and areal extent (nm^2)	N/A	
	2. Present use	N/A	
	3. Future use	N/A	
	4. Decontamination necessary prior to siting	N/A	
	E. ADDITIONAL REMARKS		

Quality of Data

● Data derived from detailed studies

◒ Estimated values

○ Insufficient data available

DESCRIPTION		
, OWNERSHIP AND LAND UTILIZATION		
Valley	$71nm^2$	100%
of valley excluded by major cultural antity-distance exclusions and 10% exclusion	$48nm^2$	68%
Siting Valley (A.1 minus A.1.a)	$23nm^2$	32%
p	DoD, U.S. Air Force, Luke AFB	
ion of siting valley with direct DoD rship	$23nm^2$	100%
ners or administrators of co-use land/ traints	None	
ous BLM or Co-Use Land (area	175	BLM (Vekol Valley)
ive location in or adjacent to valley	Adjacent to Valley north and east of LWBGR boundary	
nt use		
QUANTITY-DISTANCE EXCLUSIONS		
of 18 nm Arc (population greater ,000)	None	
of 3 nm Arc (population greater 000)	None	
	None	
ROVEMENTS		
ilroads (name)	Unnamed roads and jeep trails	
ive location in valley	Randomly transect Valley	
and use	Unimproved; military and restricted civilian	
s (type)	None	
ive location in valley	N/A	
ERNMENTAL USE AREAS	None	
and areal extent (nm^2)	N/A	
use	N/A	
se	N/A	
ination necessary prior to siting	N/A	
EMARKS		
iled studies ilable		

QUALITY OF DATA	DESCRIPTION		
	A. TOPOGRAPHIC GRADIENT IN SITING VALLEY		
●	1. Area with Less than 10% Grade	23nm^2	100%
●	2. Area with 5 to 10% Grade	0	0
●	3. Area with 0 to 5% Grade	23nm^2	100%
●	4. Location of Alluvial Passes or Valley Boundaries Having Less than 10% Grade		
	B. ROCK CONDITIONS IN SITING VALLEY (BR=Basement, B=Bedrock, VF=Volcanic Flows)		
◒	1. Exposed Rock (category/symbol/lithology)	BR/Il$_{PC}$/granitic	
◒	a. Location and map area in nm^2	1	4%
○	b. Seismic velocity (p/s in fps)		
	c. Conditions of volcanic flow	N/A	
◒	2. Pediments (rock type)		
◒	a. Location and map area in nm^2	16	70%
◒	b. Exposure condition	Thin to non-exi	
◒	c. Distance into siting valley from rock exposures (max./min./avg.) (nm)	4/0.5/3	
	C. SUBSURFACE ROCK CONDITIONS IN SITING VALLEY (BR=Basement, B=Bedrock, VF=Volcanic Flows)		
	1. Depth to Rock (map area in nm^2)		
◒	a. 0 to 250 feet (excluding pediments)	6	26%
◒	1) Type	BR, B	
○	2) Seismic velocity (p/s in fps)		
○	b. 250 to 500 feet		
○	1) Type		
○	2) Seismic velocity (p/s in fps)		
○	c. 500 to 1000 feet		
○	1) Type		
○	2) Seismic velocity (p/s in fps)		
○	d. Greater than 1000 feet		
○	1) Type		
○	2) Seismic velocity (p/s in fps)		
○	e. Unknown		

Quality of Data

● Data derived from detailed studies

◒ Estimated values

○ Insufficient data available

CRIPTION			
SITING VALLEY 10% Grade	$23nm^2$	100%	
rade	0	0	
ade	$23nm^2$	100%	
Passes or Valley ss than 10% Grade			
LEY VF=Volcanic Flows) ry/symbol/lithology)	BR/Il$_{PC}$/granitics; B/I2$_{MP}$/andesitic to basaltic volcanics		
a in nm^2	1	4%	Along flanks of Sand Tank Mountains
s in fps)			
ic flow	N/A		
a in nm^2	16	70%	Along flanks of Sand Tank Mountains
	Thin to non-existent mantle of pediment deposits		
valley from rock /avg.) (nm)	4/0.5/3		
NS IN SITING VALLEY VF=Volcanic Flows) area in nm^2)			
ding pediments)	6	26%	
	BR, B		
(p/s in fps)			
(p/s in fps)			
(p/s in fps)			
et			
(p/s in fps)			

QUALITY OF DATA	DESCRIPTION		
○	2. Rock (Section 2.2.3) in Basin-Fill Deposits (map area in nm^2)		
○	a. Type		
○	b. Depth to (ft.)		
○	c. Thickness (ft.)		
○	d. Seismic velocity (p/s in fps)		
	D. BASIN-FILL DEPOSITS IN SITING VALLEY		
●	1. Undifferentiated Deposits (A; map area in nm^2)	0	0
	a. Thickness (max./min./avg. in ft.)	N/A	
	b. Lithology	N/A	
	c. Seismic velocity (p/s in fps)	N/A	
●	2. Alluvial Fan Deposits (A_5; map area in nm^2)	6	26
○	a. Thickness (max./min./avg. in ft.)		
◒	b. Lithology	Sand, silt,	
○	c. Seismic velocity (p/s in fps)		
●	3. Playa Deposits (A_4; map area in nm^2)	0	0
	a. Thickness (max./min./avg. in ft.)	N/A	
	b. Lithology	N/A	
	c. Seismic velocity (p/s in fps)	N/A	
●	4. Wind-blown Sand (A_3; map area in nm^2)	0	0
	a. Thickness (max./min./avg. in ft.)	N/A	
	b. Lithology	N/A	
	c. Seismic velocity (p/s in fps)	N/A	
●	5. Pediment Deposits (A_6; map area in nm^2)	16	70
○	a. Thickness (max./min./avg. in ft.)		
◒	b. Lithology	Sand, grave	
○	c. Seismic velocity (p/s in fps)		
●	6. Stream Channel and Floodplain Deposits (A_1; map area in nm^2)		
○	a. Thickness (max./min./avg. in ft.)		
○	b. Lithology		
○	c. Seismic velocity (p/s in fps)		

Quality of Data
- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

3/62-A

2.3) in Basin-Fill Deposits)			
y (p/s in fps)			
IN SITING VALLEY Deposits (A; map area	0	0	
/min./avg. in ft.)	N/A		
	N/A		
y (p/s in fps)	N/A		
osits (A_5; map area in nm^2)	6	26%	
/min./avg. in ft.)			
	Sand, silt, gravel; may include fanglomerate		
y (p/s in fps)			
(A_4; map area in nm^2)	0	0	
/min./avg. in ft.)	N/A		
	N/A		
y (p/s in fps)	N/A		
(A_3; map area in nm^2)	0	0	
/min./avg. in ft.)	N/A		
	N/A		
y (p/s in fps)	N/A		
s (A_6; map area in nm^2)	16	70%	
/min./avg. in ft.)			
	Sand, gravel		
y (p/s in fps)			
nd Floodplain Deposits nm^2)			Present, but not mappable at 1:62,500 scale
/min./avg. in ft.)			
ty (p/s in fps)			

dies

QUALITY OF DATA	DESCRIPTION	
●	7. Terrace Deposits (A_2; map area in nm^2)	0
	a. Thickness (max./min./avg. in ft.)	N/A
	b. Lithology	N/A
	c. Seismic velocity (p/s in fps)	N/A
○	8. General Summary of Relationships	
	E. TECTONIC FRAMEWORK OF SITING VALLEY	
◒	1. Capable or Potentially Capable Fault	None
	a. Total length (nm)	N/A
	b. Relative location	N/A
	c. Type of faulting, regional and local attitudes (strike and dip)	N/A
	d. Minimum age of displacement or seismic activity (y.b.p.)	N/A
●	2. Volcanism	None
	a. Volcanic flows	N/A
	1) Location and map area in nm^2	N/A
	2) Minimum age of volcanic activity (y.b.p.)	N/A
	F. SEISMICITY OF SITING VALLEY (Regional seismicity discussed in Section 2.2.4 of text)	
◒	1. Relative Pre-Instrumental Historic Activity (Section 2.2.4)	None
◒	2. Site Area Seismic Activity (instrumental, 1927-1973; Section 2.2.4)	
◒	a. Events (epicenters) greater than M=6.0	None
◒	b. Events (epicenters) greater than M=1.0 and less than M=6.0	None
○	c. Events less than M=1.0 (includes microearthquakes)	
◒	3. Maximum Reported Modified Mercalli Intensity	V to VI
◒	4. Source of Possible Ground Acceleration Levels (Section 2.2.4)	Salton
◒	a. Maximum credible level (g)	0.05
◒	b. Most probable level (g)	
	G. Additional Remarks	

Quality of Data
- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

3162-B

I O N			
in nm2)	0	0	
)	N/A		
	N/A		
	N/A		
ps			
Y Fault	None		
	N/A		
	N/A		
local attitudes	N/A		
eismic activity	N/A		
	None		
	N/A		
	N/A		
vity	N/A		
al seismicity oric Activity	None		
strumental,			
M=6.0	None		
M=1.0 and less	None		
microearthquakes)			
lli Intensity	V to VI (?)		
eration Levels	Salton Trough (Zone 1)	Transition Zone (Zone 2)	Diffuse Seismicity (Zone 3)
	0.05	0.2	0.2
		0.1	

SOILS ENGINEERING PROPERTIES (1)	MAP	
	26	27
Unified soil classification (2)	(GM-SM)	GM-SM
AASHO soil classification	(A-1,A-2)	A-1,A-2
Percent passing #4 sieve		35-80
Percent passing #40 sieve		30-55
Percent passing #200 sieve		15-35
Liquid limit/plasticity index		NP/NP
Surface consistency		
Dry density (pcf)		
Permeability (cm/sec)		10^{-2} to 10
In-situ shear strength (psi)		
In-situ angle of internal friction (degrees)		
Cohesion (psi)		
Shrink-swell potential		Low
Coefficient of compressibility (in^2/lb.)		
In-situ CBR		
Recompacted CBR		
General surface moisture condition		
Compressional wave velocities (fps)		
Shear wave velocities (fps)		
Deleterious substances	Caliche present	Caliche pre in some are
ENGINEERING DESIGN EVALUATIONS (1)		
Suitability as impermeable membrane when recompacted	(Poor)	Poor
Suitability as source of sand/fill material	(Fair)/(Fair)	Fair/Good
Suitability as source of aggregate/base course	(Fair)/(Fair)	Fair/Fair
Near surface foundation design characteristics	(High strength)	Mod. streng Low comp.
Excavation limitations and slope angle	(Difficult ripping or blasting)	Sloughing difficult
Additional Remarks	Highly cemented; ($A5_T$)	Highly alka corrosive t uncoated s ($A5_{QT}$; $A5c_Q$

Explanation

(blank box)	No literature available and data not extrapolated
(SP-SM)	No literature available and data extrapolated
SP-SM	Data available in literature

(1) Surface soils only, depth of less than 5 feet

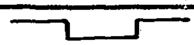
(2) Related geologic unit(s) shown in Additional Remarks (e.g. Al_Q)

ERING PROPERTIES(1)	MAP UNIT NUMBER 26	27	29
lassification(2)	(GM-SM)	GM-SM	(GM-SM)
ssification	(A-1,A-2)	A-1,A-2	(A-1,A-2)
g #4 sieve		35-80	
g #40 sieve		30-55	
g #200 sieve		15-35	
lasticity index		NP/NP	
tency			
cf)			
(cm/sec)		10^{-2} to 10^{-4}	
strength (psi)			
of internal friction (degrees)			
)			
potential		Low	
f compressibility ($in^2/lb.$)			
BR			
ce moisture condition			
wave velocities (fps)			
locities (fps)			
bstances	Caliche present	Caliche present in some areas	
DESIGN EVALUATIONS(1)			
s impermeable membrane when recompacted	(Poor)	Poor	(Poor)
s source of sand/fill material	(Fair)/(Fair)	Fair/Good	(Fair)/(Good)
s source of aggregate/base course	(Fair)/(Fair)	Fair/Fair	(Fair)/(Fair)
foundation design characteristics	(High strength)	Mod. strength Low comp.	(Mod. strength)
itations and slope angle	(Difficult ripping or blasting)	Sloughing and/or difficult ripping	(Difficult ripping or blasting)
Additional Remarks	Highly cemented; ($A5_T$)	Highly alkaline; corrosive to uncoated steel; ($A5_{QT}$; $A5c_Q$)	Depth to rock less than 10 feet; ($A6_Q$)

literature available and data not extrapolated
literature available and data extrapolated
ta available in literature
) Surface soils only, depth of less than 5 feet
) Related geologic unit(s) shown in Additional Remarks (e.g. $A1_Q$)

QUALITY OF DATA	DESCRIPTION	
	A. SURFACE WATER IN SITING VALLEY	
●	1. Playas; Intermittent and Perennial Lakes	None
	a. Duration of surface water (wks.)	N/A
	b. Maximum extent (nm^2)	N/A
	c. Water depth (avg. in ft.)	N/A
	d. Source of water	N/A
	e. Water quality	N/A
◒	2. Springs	None
	a. Duration of flow (wks.)	N/A
	b. Estimated maximum flow rate (gpm/season)	N/A
	c. Water quality	N/A
○	3. Rivers or Streams	Bender Wash
○	a. Rate (gpm) and duration of flow (wks.)	Ephemeral
○	b. Water quality	
	B. HYDROLOGIC CHARACTERISTICS OF SITING VALLEY	
◒	1. Drainage Channel (PR=Primary; S=Secondary)	Bender Wash
◒	a. Depth of incision (max./min./avg.; ft.)	
◒	b. Width (max./min./avg.; ft.)	100/25 est.
◒	c. Gradient (ft./mi.)	100
◒	d. Channel bottom characteristics	Gravel, san
◒	e. Channel cross-section (schematic)	
◒	f. Channel spacing (avg. in ft.)	Main channe
○	g. Preliminary flood susceptibility rating (Section 2.4.1)	
○	2. Preliminary Flood Susceptibility Rating of Major Landform Surfaces (Section 2.4.1)	
○	a. Undifferentiated deposits	
○	b. Alluvial fans	
○	c. Playas (active=a; mantled=m)	
○	d. Pediments	
○	e. Sand dunes	
○	f. Terraces (l=lake; r=river)	
	C. ADDITIONAL REMARKS	Observatio interpretat

Quality of Data
- ● Data derived from detailed studies
- ◒ Estimated values
- ○ Insufficient data available

TION		
LEY		
d Perennial Lakes	None	
er (wks.)	N/A	
	N/A	
.)	N/A	
	N/A	
	N/A	
	None	
	N/A	
rate (gpm/season)	N/A	
	N/A	
	Bender Wash	Numerous unnamed streams
of flow (wks.)	Ephemeral	Ephemeral
OF SITING VALLEY		
imary; S=Secondary)	Bender Wash (PR)	Numerous unnamed washes (S)
./min./avg.; ft.)		
ft.)	100/25 est./50 to 75	
	100	50 to 100
eristics	Gravel, sand, cobbles	Gravel, sand, cobbles
(schematic)		
in ft.)	Main channel	
eptibility rating		
eptibility Rating of s (Section 2.4.1)		
its		
led=m)		
ver)		
	Observations are based mainly on a brief aerial reconnaissance and interpretation of topographic maps and aerial photographs.	

QUALITY OF DATA	DESCRIPTION		
	A. DEPTH TO GROUNDWATER WITHIN BASIN-FILL MATERIAL IN SITING VALLEY (Map area in nm^2)		
○	1. 0 to 50 feet		
○	a. 0 to 25 feet		
○	b. 25 to 50 feet		
○	2. 50 to 100 feet		
○	3. Greater than 100 feet		
○	4. Unknown or not Present	23	100%
	B. AQUIFER CHARACTERISTICS IN VALLEY		
◒	1. Type of Aquifer (B=Basin Fill; P=Perched; R=Rock; u=unconfined; c=confined)	See Additi	
○	a. Map area and extent		
◒	b. Depth to aquifer (ft.)		
○	c. Thickness (ft.)	158	
◒	d. Composition	Granitic basement r	
○	e. Porosity (%)		
○	f. Specific yield (%)		
○	g. Transmissivity ($ft.^2/day$)		
○	h. Specific capacity (gpm/ft. of drawdown)		
○	i. Total pumpage (ac. ft./unit time)		
○	j. Groundwater ownership rights	Luke AFB	
	C. WATER BUDGET FOR VALLEY		
○	1. Total Recharge (ac. ft./unit time)		
○	2. Total Discharge (ac. ft./unit time)		
	D. ADDITIONAL REMARKS	(a) Rock aquifer i	

Quality of Data
● Data derived from detailed studies
◒ Estimated values
○ Insufficient data available

DESCRIPTION			
A. DEPTH TO GROUNDWATER WITHIN BASIN-FILL MATERIAL IN SITING VALLEY (Map area in nm^2)			
1. 0 to 50 feet			
a. 0 to 25 feet			
b. 25 to 50 feet			
2. 50 to 100 feet			
3. Greater than 100 feet			
4. Unknown or not Present	23	100%	Unknown
B. AQUIFER CHARACTERISTICS IN VALLEY			
1. Type of Aquifer (B=Basin Fill; P=Perched; R=Rock; u=unconfined; c=confined)	Ru See Additional Remarks (a)		
a. Map area and extent			
b. Depth to aquifer (ft.)			
c. Thickness (ft.)	158		
d. Composition	Granitic basement rock (Il_{PC})		
e. Porosity (%)			
f. Specific yield (%)			
g. Transmissivity (ft.^{2}/day)			
h. Specific capacity (gpm/ft. of drawdown)			
i. Total pumpage (ac. ft./unit time)			
j. Groundwater ownership rights	Luke AFB		
C. WATER BUDGET FOR VALLEY			
1. Total Recharge (ac. ft./unit time)			
2. Total Discharge (ac. ft./unit time)			
D. ADDITIONAL REMARKS	(a) Rock aquifer is fracture system		

lity of Data
ata derived from detailed studies
stimated values
nsufficient data available

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER Volume II b	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

Same

18. SUPPLEMENTARY NOTES

None

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Sheleter concept	Nevada	Land Mobile Missile
Pool concept	New Mexico	
Trench concept	Arizona	
MX siting investigation	DoD lands	

(over)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The report presents the results of a review of existing geotechnical information regarding YPG/LWBGR. The available information is presented in Data Summary Sheets and on maps and overlays at a scale of 1:62,500. Subjects covered are soils engineering, surface and groundwater hydrology, topography and geology, and cultural and ownership features. The study is for MX siting considerations.

19.. Key words contined

Quantity distance exclusions
Geotechnical siting
Groundwater
Soils engineering
Geology
Environmental assessment
Siting area

APPENDIX A

BIBLIOGRAPHY

ADDENDUM TO BIBLIOGRAPHY

SOURCES OF PERSONAL COMMUMINCATION

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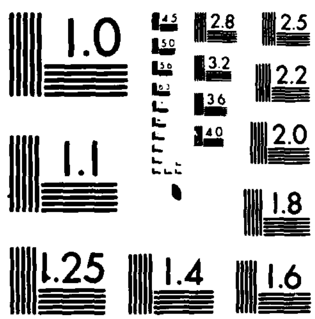

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APPENDIX B

GEOLOGIC TIME SCALE

GEOLOGIC UNIT SYMBOL EXPLANATION

GEOLOGIC TIME SCALE

ERA	PERIOD	EPOCH	BEGINNING OF INTERVAL*
CENOZOIC	QUATERNARY	HOLOCENE (Recent)	10,000
		PLEISTOCENE	2 my
	TERTIARY	PLIOCENE	5 my
		MIOCENE	23 my
		OLIGOCENE	36 my
		EOCENE	53 my
		PALEOCENE	65 my
MESOZOIC	CRETACEOUS		135 my
	JURASSIC		190 my
	TRIASSIC		230 my
PALEOZOIC	PERMIAN		280 my
	PENNSYLVANIAN		320 my
	MISSISSIPPIAN		345 my
	DEVONIAN		395 my
	SILURIAN		435 my
	ORDOVICIAN		500 my
	CAMBRIAN		570 my
PRECAMBRIAN			

*IN YEARS BEFORE PRESENT: my = MILLION YEARS
MODIFIED AFTER BERGGREN, 1972; NEWMANN, 1970

GEOLOGIC UNIT SYMBOL EXPLANATION

ROCK

Shown in regions where rock is exposed; the areally predominant (greater than 70 percent) rock type is indicated. Rock may be subdivided into bedrock [B], basement rock [BR] or surface volcanic flows [VF].

I IGNEOUS (UNDIFFERENTIATED). Rocks formed by solidification of a molten or partially molten mass [B, BR, or VF].

- **I_1** Intrusive. Typically crystalline, formed by the solidification of molten material below the surface (i.e., granite, syenite, diorite). [BR].
- **I_2** Extrusive (undifferentiated). Formed by solidification of molten material at or near the surface [BR].
- **I_3** Extrusive (flows). True extrusive rocks formed by solidification of molten material on the surface (basalt, dacite, etc.). [VF]. Pattern denotes young basaltic flows which overlie basin fill materials.
- **I_4** Extrusive (volcaniclastics). Formed by welding or cementation of deposits of volcanic ejecta (i.e., tuff, agglomerate). [B or VF].

S SEDIMENTARY (UNDIFFERENTIATED). Coarse- to fine-grained materials that exhibit some degree of cementation and were deposited by water, wind, gravity, or evaporation [B].

- **S_1** Sandstone. Composed predominantly of sand size particles.
- **S_2** Limestone and Dolomite. Composed predominantly of carbonate material.
- **S_3** Shale. Composed predominantly of clay and silt size particles (i.e., shale, siltstone).
- **S_4** Evaporites. Composed of salt materials which result from precipitation (i.e., gypsum, anhydrite, halite).
- **S_5** Clastics. Composed of particles which range from silt- to boulder-size particles. May be angular or rounded (i.e., conglomerate, breccia).

M METAMORPHIC (UNDIFFERENTIATED). Rocks formed through alteration of igneous or sedimentary rock material by pressure, heat, or chemical changes below the weathered zone (i.e., gneiss, schist, slate, marble, quartzite). [B or BR].

C ROCK COMPLEXES. Indicated where no areally predominant (greater than 70 percent) rock type occurs [B, BR, or VF].

GEOLOGIC UNIT SYMBOL EXPLANATION

BASIN-FILL DEPOSITS

A SURFICIAL DEPOSITS (UNDIFFERENTIATED). Fine- to coarse-materials deposited principally by wind, water or gravity.

A_1 Stream Channel and Floodplain Deposits. Sand- to boulder-size fragments. Admixture of silt and clay, deposited principally by water.

A_2 Terrace Deposits. Clay, silt, sand and gravel materials. Principally stream or lake deposits.

A_3 Wind-Blown Sand. Principally sand size particles deposited by wind, in sheets (A_{3s}) or dunes (A_{3d}). May be active or inactive.

A_4 Playa Deposits. Principally clay and silt size particles, may have admixtures of sand and gravel. Principally deposited in thin laminae by water and evaporation. Inactive playa deposits (A_{4m}) may be mantled by a thin cover of alluvial or wind-blown material.

A_5 Alluvial Fan Deposits. Subrounded to angular silt- to boulder-sized particles. Deposited principally by water and gravity in areas below mountain fronts. Coarse grained facies (A_{5c}) have greater than 70 percent of their outcrop area covered by gravel. Coalescing alluvial fans form bajadas. Where geologic ages Q, QT or T have not been assigned, fan deposits are either undifferentiated (u) or relative ages are indicated by o - oldest, i - intermediate or y - youngest.

A_6 Pediments and Pediment Deposits (Undifferentiated). Planated bedrock shelf generally overlain by thin mantle (up to 10 feet) of sand- to boulder-size residual or alluvial material. May be a surface of transport.

GEOLOGIC AGES OF UNITS

Q Quaternary (<2 m.y.)

QT Quaternary or Tertiary (<65 m.y.)

T Tertiary (2 - 65 m.y.)

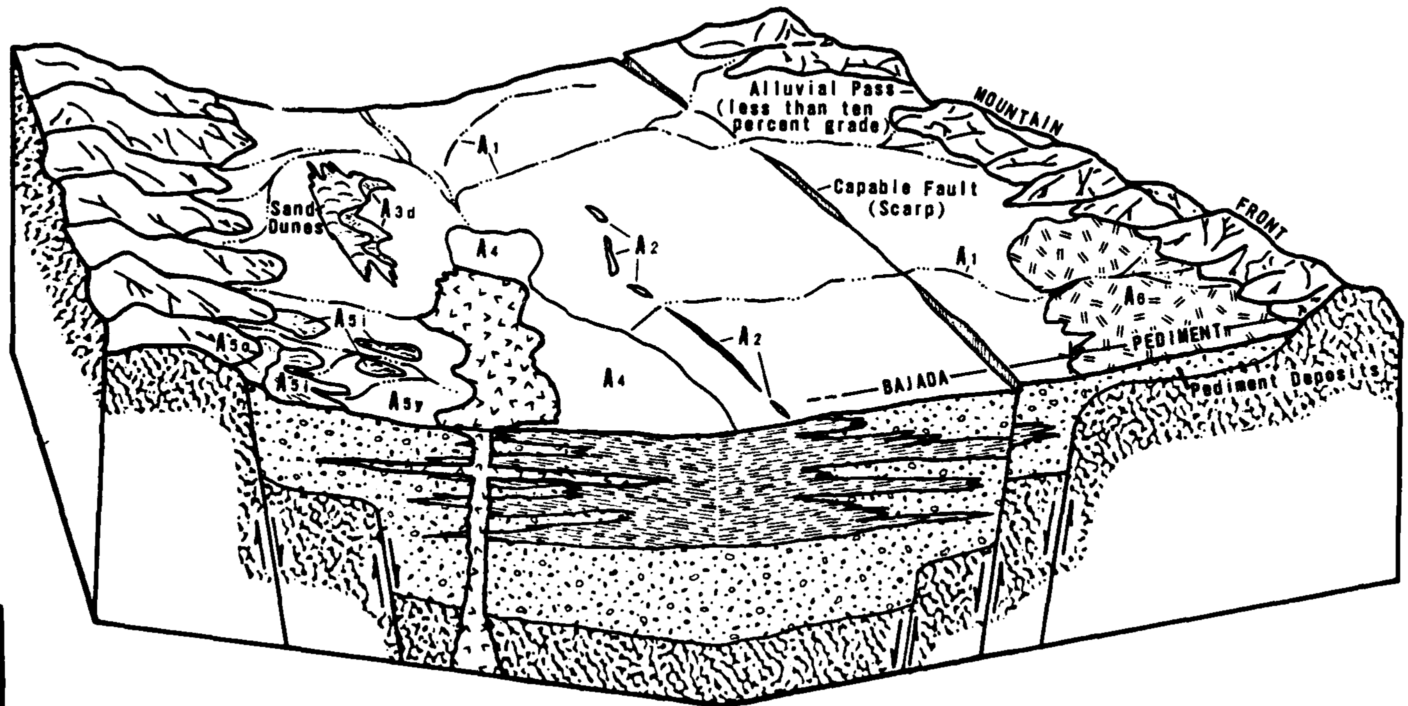
MP Mesozoic or Paleozoic (65 - 570 m.y.)

P€ Precambrian (>570 m.y.)

APPENDIX C

GEOMORPHIC AND GEOLOGIC FEATURES

DATE: 30 JUNE 1975



EXPLANATION

BASIN-FILL DEPOSITS

COARSE-GRAINED: Gravel, sand and silt; grain size commonly decreases basinward. Deposits include:

- A_1-Stream and undifferentiated floodplain
- A_2-Terrace
- A_{3d}-Sand (dunes)
- A_5-Alluvial fan; o=older, i=intermediate, y=younger
- A_6-Pediment

FINE-GRAINED: Clay and silt; deposited in Pleistocene lake; A_4-Playa.

ROCK

ROCK

VOLCANIC FLOW ROCK

PEDIMENT

GEOMORPHIC AND GEOLOGIC FEATURES

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

APPENDIX C-1

FUGRO NATIONAL, INC.

APPENDIX D

MODIFIED MERCALLI INTENSITY SCALE

NRC CRITERIA DEFINING A CAPABLE FAULT

MODIFIED MERCALLI INTENSITY SCALE OF 1931

As abridged and used by the National earthquake
Information Center of the U.S. Department of Commerce

I. Not felt except by a very few under specially favorable circumstances. (I Rossi-Forel Scale)

II. Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing. (I to III Rossi-Forel Scale)

III. Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor-cars may rock slightly. Vibration like passing of truck. Duration estimated. (III Rossi-Forel Scale)

IV. During the day, felt indoors by many, outdoors by few. At night, some awakened. Dishes, windows, doors disturbed; walls make creaking sound. Sensation like heavy truck striking building. Standing motor-cars rocked noticeably. (IV to V Rossi-Forel Scale)

V. Felt by nearly everyone, many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop. (V to VI Rossi-Forel Scale)

VI. Felt by all, many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight. (VI to VII Rossi-Forel Scale)

VII. Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly-built or badly designed structures; some chimneys broken. Noticed by persons driving motor-cars. (VIII Rossi-Forel Scale)

VIII. Damage slight in specially designed structures; considerable in ordinary, substantial buildings, with partial collapse; great in poorly-built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motor-cars disturbed. (VIII+ to IX Rossi-Forel Scale)

IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken. (IX+ Rossi-Forel Scale)

X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with their foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks. (X Rossi-Forel Scale)

XI. Few, if any, masonry structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.

XII. Damage total. Waves seen on ground surfaces. Lines of sight and level distorted. Objects thrown upward into air.

NRC CRITERIA DEFINING A CAPABLE FAULT

A "capable fault" is a fault which has exhibited one or more of the following characteristics:

1) movement at or near the ground surface at least once within the past 35,000 years, or recurring movement within the past 500,000 years;

2) macro-seismicity instrumentally determined with records of sufficient precision to demonstrate a direct relationship with the fault;

3) structural relationship to a capable fault, according to (1) or (2), such that movement on one could be reasonably expected to be accompanied by movement on the other.

Source: U. S. Atomic Energy Commission, 1973, Reactor Site Criteria: Title 10 - Rules and Regulations, pt. 100, p. 237-238.

APPENDIX E

UNIFIED SOIL CLASSIFICATION SYSTEM

AASHO SOIL CLASSIFICATION SYSTEM

UNIFIED SOIL CLASSIFICATION SYSTEM

Major Divisions			Group Symbols	Typical Names	Field Identification Procedures (Excluding particles larger than 3 inches and basing fractions on estimated weights)			Information Required for Describing Soils
1	2		3	4	5			6
Coarse-grained Soils More than half of material is larger than No. 200 sieve size. The No. 200 sieve size is about the smallest particle visible to the naked eye.	Gravels More than half of coarse fraction is larger than No. 4 sieve size. (For visual classification, the ¼-in. size may be used as equivalent to the No. 4 sieve size)	Clean Gravels (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.			For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics.
			GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.			
		Gravels with Fines (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures.	Nonplastic fines or fines with low plasticity. (for identification procedures see ML below)			Give typical name; indicate approximate percentages of sand and gravel, max. size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbol in parentheses.
			GC	Clayey gravels, gravel-sand-clay mixtures.	Plastic fines (for identification procedures see CL below).			
	Sands More than half of coarse fraction is smaller than No. 4 sieve size.	Clean Sands (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines.	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.			
			SP	Poorly-graded sands, gravelly sands, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.			Example:
		Sands with Fines (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures.	Nonplastic fines or fines with low plasticity. (for identification procedures see ML below)			Silty sand, gravelly; about 20% hard, angular gravel particles ½-in. maximum size; rounded and subangular sand grains coarse to fine; about 15% nonplastic fines with low dry strength; well compacted and moist in place; alluvial sand; (SM).
			SC	Clayey sands, sand-clay mixtures.	Plastic fines (for identification procedures see CL below).			
Fine-grained Soils More than half of material is smaller than No. 200 sieve size.					Identification Procedures on Fraction Smaller than No. 40 Sieve Size			
					Dry Strength (Crushing characteristics)	Dilatancy (Reaction to shaking)	Toughness (Consistency near PL)	
	Silts and Clays Liquid limit less than 50		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.	None to slight	Quick to slow	None	Give typical name, indicate degree and character of plasticity, amount and maximum size of coarse grains, color in wet condition, odor if any, local or geologic name, and other pertinent descriptive information; and symbol in parentheses.
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	Medium to high	None to very slow	Medium	
			OL	Organic silts and organic silty clays of low plasticity.	Slight to medium	Slow	Slight	For undisturbed soils and information on structure, stratification, consistency in undisturbed and remolded states, moisture and drainage conditions.
	Silts and Clays Liquid limit greater than 50		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	Slight to medium	Slow to none	Slight to medium	
			CH	Inorganic clays of high plasticity, fat clays.	High to very high	None	High	
			OH	Organic clays of medium to high plasticity, organic silts.	Medium to high	None to very slow	Slight to medium	Example:
Highly Organic Soils			Pt	Peat and other highly organic soils.	Readily identified by color, odor, spongy feel and frequently by fibrous texture.			Clayey silt, brown, slightly plastic, small percentage of fine sand, numerous vertical root holes, firm and dry in place, loess, (ML).

AASHO SOIL CLASSIFICATION SYSTEM

General classification	Granular materials (35% or less passing No. 200)							Silt-clay materials (more than 35% passing No. 200)			
	A-1			A-2							A-7
Group classification	A-1-a	A-1-b	A-3	A-2-4	A-2-5	A-2-6	A-2-7	A-4	A-5	A-6	A-7-5, A-7-6
Sieve analysis, % passing:											
No. 10	50 max	......	......	......	......	......	......	......	......	......	
No. 40	30 max	50 max	51 min	......	......	......	......	......	......	......	
No. 200	15 max	25 max	10 max	35 max	35 max	35 max	35 max	36 min	36 min	36 min	36 min
Characteristics of fraction passing No. 40:											
Liquid limit	......		......	40 max	41 min	40 max	41 min	40 max	41 min	40 max	41 min
Plasticity index	6 max		N.P.	10 max	10 max	11 min	11 min	10 max	10 max	11 min	11 min†
Usual types of significant constituent materials	Stone fragments, gravel and sand		Fine sand	Silty or clayey gravel and sand				Silty soils		Clayey soils	
General rating as subgrade	Excellent to good					Fair to poor					

* After AASHO [1].

† Plasticity index of A-7-5 subgroup is equal to or less than LL minus 30. Plasticity index of A-7-6 subgroup is greater than LL minus 30.

APPENDIX F

SPECIFIC SOIL TEST DATA

SPECIFIC SOILS ENGINEERING TEST DATA

(For locations, see Soil Engineering Overlays Y-I through Y-IV, Y-VI through Y-X, and Y-XII through Y-XV.)

Number	Depth (ft.)	Method of Exploration	Remarks
50 (a)	0-2	Surface Sampling	Sampling of in-situ subgrade at auxiliary airfield o Liquid limit = 25 o Plasticity index = NP o Unified classification = SM-ML o AASHO classification = A-4 o Optimum density = 114-121 pcf o Recompacted CBR o Range = 32 to 79 o Average = 55
51 (b)	0-2	Surface Sampling	Sampling of in-situ subgrade at auxiliary airfield o Liquid limit = 25 o Plasticity index = NP o Unified classification = SM-ML o AASHO classification = A-4 o Optimum density = 115-130 pcf o Recompacted CBR o Range = 23 to 98 o Average = 63
52 (c)	0-2	Surface Sampling	Sampling of in-situ subgrade at auxiliary airfield o Liquid limit = 25 o Plasticity index = NP o Unified classification = SM-ML o AASHO classification = A-4 o Optimum density = 117-123 pcf o Recompacted CBR o Range = 15 to 70 o Average = 35

SPECIFIC SOILS ENGINEERING TEST DATA

(For locations, see Soil Engineering Overlays Y-I through Y-IV, Y-VI through Y-X, and Y-XII through Y-XV.)

Number	Depth (ft.)	Method of Exploration	Remarks
53 (d)	0-2	Surface Sampling	Sampling of in-situ subgrade at auxiliary airfield o Liquid limit = 25 o Plasticity index = NP o Unified classification = SM o AASHO classification = A-2, A-4 o Optimum density = 112-119 o Recompacted CBR o Range = 22 to 50 o Average = 37
54 (e)	0-2	Surface Sampling	Sampling of subgrade at auxiliary airfield o Liquid limit = 25 o Plasticity index = NP o Unified classification = SM-ML o AASHO classification = A-2, A-4 o Optimum density = 115-121 pcf o Recompacted CBR o Range = 19 to 78 o Average = 40
55 (f)	0-2	Surface Sampling	Sampling of subgrade at auxiliary airfield o Liquid limit = 25 o Plasticity index = NP o Unified classification = SM-ML o AASHO classification = A-2, A-4 o Optimum density = 116-127 pcf o Recompacted CBR o Range = 10 to 96 o Average = 53

SPECIFIC SOILS ENGINEERING TEST DATA

(For locations, see Soil Engineering Overlays Y-I through Y-IV, Y-VI through Y-X, and Y-XII through Y-XV.)

Number	Depth (ft.)	Method of Exploration	Remarks
56 (g)	0-1	Surface Sampling	Mechanical analysis o Unified classification = GM-SM o AASHO classification = A-2
57 (g)	0-1	Surface Sampling	Mechanical analysis o Unified classification = GP-SP o AASHO classification = A-1, A-2
58 (g)	0-1	Surface Sampling	Mechanical analysis o Unified classification = GM-SM o AASHO classification = A-2
59 (h)	0-9.0	Auger borings	Sampling of subgrade soils at auxiliary airfield o Specific gravity = 2.70 o Unit weight in place = 94 pcf o Optimum density = 120 pcf o Optimum moisture = 12.5 pcf o Liquid limit = 11 to 26 o Plasticity index = 0 to 8 o Unified classification = CL-ML, SM o AASHO classification = A-2, A-4

(a) U.S. Army Corps of Engineers, 1944d; (b) U.S. Army Corps of Engineers, 1944a; (c) U.S. Army Corps of Engineers, 1944f; (d) U.S. Army Corps of Engineers, 1944c; (e) U.S. Army Corps of Engineers, 1944b; (f) U.S. Army Corps of Engineers, 1944e; (g) Yuma Proving Ground Analysis and Certification Branch, 1970; (h) U.S. Army Corps of Engineers, 1942b.

APPENDIX G

WELL AND WATER QUALITY DATA

LOCATION OF WATER WELLS AND OTHER BORINGS NOT SHOWN ON FOUR-QUAD OVERLAYS

RECORD OF WELLS

WELL NUMBER	WELL LOCATION (TOWNSHIP. RANGE.SECTION)	OWNER	YEAR COMPLETED	WELL SURFACE ELEVATION-FEET (FT.) ABOVE MEAN SEA LEVEL (M.S.L)	COMPLETED DEPTH (FT.)	DIAMETER (IN.) C=DIAMETER CASING	METHOD OF CONSTRUCTION	TYPE OF PUMP	PERFORATED INTERVAL (FT.)	DEPTH TO ROCK (FT.)	DEPTH (FT.)
1	1.20.12			1177	960						Dry
2	1.20.26			1260 (est)	700						Dry
3	6.21.3	YPG	1960	401 (est)	300	c=10					210
4	6.21.34	YPG	1958	370	271	c=8					199
5	7.21.10	YPG	1952	322 (est)	282	c=10					169
6	5.19.19	YPG	1969	855 (est)	1000		Drilled		680-980	190	780
7	6.20.19	YPG	1958	450 (est)	400	c=8					292
8	6.20.21	YPG	1959	485 (est)	502	c=14			262-474		330
9	6.20.32	YPG	1952	419 (est)	500	24 c=10					252
10	6.20.32	YPG		412 (est)	320	c=10					260
11	6.18.32	YPG	1973	720 (est)	739	20 c=12	Drilled		551-695	705	507
12	5.15.22	YPG		565	950		Drilled				231
13	5.15.28	YPG		549 (est)	221						221
14	5.15.28	YPG	1968	550	1105		Drilled				222
15	6.15.14	YPG	1946	556 (est)	79						Dry
16	6.15.15	YPG	1972	462	1109	22	Drilled		785-985		165
17	11.21.4	US Bur. of Rec.	1964	403	373	c=6	Drilled		294-328		296
18	12.21.17	US Bur. of Rec.	1966	356	320	c=2	Drilled		318-320		285
19	12.21.14	US Bur. of Rec.	1966	422	369	c=2	Drilled		367-369		34[illegible]

							CHEMICAL ANALY								
INTERVAL (FT.)	DEPTH TO ROCK (FT.)	WATER LEVEL			PUMPING DATA										
		DEPTH (FT.)	DATE MEASURED	ELEVATION (FT. ABOVE M.S.L.)	YIELD / DRAWDOWN (gpm/ft)	SPECIFIC CAPACITY (gpm/ft)	DATE SAMPLED	TEMPERATURE (°C)	GEOLOGIC SOURCE	SILICA (SiO_2) (mg/l)	IRON (Fe) (mg/l)	CALCIUM (Ca) (mg/l)	MAGNESIUM (Mg) (mg/l)	SODIUM AND POTASSIUM (Na+K) (mg/l)	BICARBONATE (HCO_3) (mg/l)
		Dry													
		Dry													
		210		191	45/2	22.5	1966		A	27.0	0.0	81	7.0	Na 156 K 24	141
		199		171	65/1	65	1966		A_2	20.5	0.03	65	5.0	Na 176 K 29	128
		169		153	225/2	112.5	1966		A_2	29	0.0	44	6.0	Na 204 K 29	129
0-980	190	780	1969	75	300/10	30		45.5	I_{2T}	45		6.8	1.5	208	116
		292		158	290/7.5	38.7			A						
2-474		330		155	25		1966	40	A	42	0.08	22	1.2	334	91
		252		167	90/2	45	1966		A	29.5	0.02	54	10	Na 214 K 25	105
		260		152	500/5	100			A						
1-695	705	507	[illegible]	212			2-73		A_{5T}	29				Na 235 K 7.1	116
		231		334					A						
		221	1968	328					A						
		222	1968	328			10-57		A	16	3.6	189	9.2	321	34
		Dry	1946						A						
5-985		165	1972	297											
4-328		296	1971	403			1-65	33.3		24		94	26	Na 225 K 5.5	218
3-320		285	12-66	71			12-67	35.4	A						
7-369		346	11-66	76			12-67	31.5	A						

AL ANALYSIS OF WELL WATER

SODIUM AND POTASSIUM (Na+K) (mg/l)	BICARBONATE (HCO_3) (mg/l)	SULFATE (SO_4) (mg/l)	FLUORIDE (F) (mg/l)	CHLORIDE (Cl) (mg/l)	NITRATE (NO_3) (mg/l)	MANGANESE (Mn) (mg/l)	PHOSPHATE (PO_4) (mg/l)	BORON (B) (mg/l)	DISSOLVED SOLIDS (Sum) (mg/l)	WATER TYPE (Section 2.4)	HARDNESS AS $CaCO_3$ CALCIUM, MAGNESIUM (mg/l)	HARDNESS AS $CaCO_3$ NON-CARBONATE (mg/l)	SPECIFIC CONDUCTANCE (Micromhos at 25°C)
										F			
										F			
156 24	141	140	6.00	255	1.35	1.10		0.55	829	F	167	62	1330
176 29	128	133	6.75	230	1.10	1.25		0.60	821	F	85	0	1290
204 29	129	138	7.25	250	0.95	1.0		1.30	890	F	63	0	1380
208	116	120	9.0	165					613 (calc)	F	23		1030
334	91	198	7.2	354	1.3	0.16		0.0	992	F	46	0	1600
214 25	105	182	5.50	292	1.45	1.30		1.15	1035	SS	86	0	1600
235 7.1	116	175	3.2	238					783 (calc)	F	100	5	1360
321	34	517	1.9	440	20				1530 (calc)	SS	510	482	2340
225 5.5	218	92	0.4	398	0.4			0.30	972	F	340	160	1770

R											
[illegible]3 (mg/1)	MANGANESE (Mn) (mg/1)	PHOSPHATE (PO_4) (mg/1)	BORON (B) (mg/1)	DISSOLVED SOLIDS (Sum) (mg/1)	WATER TYPE (Section 2.4)	HARDNESS AS $CaCO_3$ CALCIUM, MAGNESIUM (mg/1)	HARDNESS AS $CaCO_3$ NON-CARBONATE (mg/1)	SPECIFIC CONDUCTANCE (Micromhos at 25°C)	pH	PERCENT SODIUM	REMARKS
					F						
					F						*(est)=Estimated from topographic map
35	1.10		0.55	829	F	167	62	1330	7.27		Arsenic(As) = 0.01
10	1.25		0.60	821	F	85	0	1290	7.67		As = 0.02
95	1.0		1.30	890	F	63	0	1380	7.70		As = 0.02
				613 (calc)	F	23		1030	8.3		Bedrock aquifer Bedrock (I_{2T})
3	0.16		0.0	992	F	46	0	1600	8.3	92	
45	1.30		1.15	1035	SS	86	0	1600	7.91		As = 0.03
				783 (calc)	F	100	5	1360	7.9		Well sealed w/hinged cap. Basement (I_{1MP})
				1530 (calc)	SS	510	482	2340	6.9		
											Well sealed w/hinged cap.
			0.30	972	F	340	160	1770	7.7	58	

RECORD OF WELLS

WELL NUMBER	WELL LOCATION (TOWNSHIP. RANGE. SECTION)	OWNER	YEAR COMPLETED	WELL SURFACE ELEVATION-FEET (FT.) ABOVE MEAN SEA LEVEL (M.S.L)	COMPLETED DEPTH (FT.)	DIAMETER (IN.) C=DIAMETER CASING	METHOD OF CONSTRUC-TION	TYPE OF PUMP	PERFORATED INTERVAL (FT.)	DEPTH TO ROCK (FT.)	WA DEPTH (FT.)
20	12.21.25	US Bur. of Rec.	1966	455	410	4 3/4 (min)	Drilled		408-410		384
21	13.20.2	US Bur. of Rec.	1966	577	1427	5 3/8 (min)	Drilled		1198-1200		500
22	14.15.7			1174	35		Dug			0	27
23	15.10.22	B. Sport Fish & Wildlife	1972	908 909	400		Drilled			225	232 [illegible]
24	8.13.21			367	700		Drilled				54
25	9.13.21			390	47		Dug				46
26	10.12.6			480 (est)	126		Dug				121
27	12.11.16			741 (est)	300		Dug (?)				dry
28	10.6.30			1237 (est)	500						460
29	12.8.17			1080 (est)	35						
30	12.7.23		1940	1705 (est)	42		Dug			0	12
31	13.9.24			838 (est)	440		Drilled				
32	9.6.23			1160	731					615	607
33	6.5.25	Luke AFB	1963	850 (est)	646				340-560	634	285
34	6.5.23	Luke AFB		841 (est)	405						255
35	6.5.25	Luke AFB		855 (est)	400						261
36	7.5.6			862 (est)	280	c=6					271
37	8.5.2			1120 (est)	495	c=6					408
38	8.2.11			2405 (est)	75		Drilled			0	60

						CHEMICAL ANALYSIS									
DEPTH TO ROCK (FT.)	WATER LEVEL			PUMPING DATA											
	DEPTH (FT.)	DATE MEASURED	ELEVATION (FT. ABOVE M.S.L.)	YIELD / DRAWDOWN (gpm/ft)	SPECIFIC CAPACITY (gpm/ft)	DATE SAMPLED	TEMPERATURE (^{o}C)	GEOLOGIC SOURCE	SILICA (SiO_2) (mg/l)	IRON (Fe) (mg/l)	CALCIUM (Ca) (mg/l)	MAGNESIUM (Mg) (mg/l)	SODIUM AND POTASSIUM (Na+K) (mg/l)	BICARBONATE (HCO_3) (mg/l)	SULFATE (SO_4) (mg/l)
	384	10-66	76			12-67	32.5	A							
	500	11-67	76 77		-	12-67	37.6	A							
0	27		1147			10-17	20.5	I_{1MP}	39	0.13	44	19	Na 698 K 12	578	632
225	232		676			1972	26.4	I_{1MP}							
	54		313					A							
	46		344			11-17		A	47	0.48	71	15	21	258	0.17
	121		268					A							
	dry														
	460		777					A							
0	12	1956	1693	500 g/ day/?				A_6							
615	607		553	400/?				A_{5T}							
634	285		565			12-72	34	A			41	3.5	Na 330 K 4.7	60	150
	255		586			5-51 4-53	30 28	A	31		50	3.1	331	62 63	152
	261		594			5-51	31	A	39		54	3.3	331	64	151
	271		591			1-46 4-53	26.6	A			36	4.4	227	107 134	124
	408	1953	712			1-46 4-53	25.6 26.7	A	40		23 48	18 24	102 108	303 260	34 105
0	60		2345												

N

2

NALYSIS OF WELL WATER

BICARBONATE (HCO_3) (mg/l)	SULFATE (SO_4) (mg/l)	FLUORIDE (F) (mg/l)	CHLORIDE (Cl) (mg/l)	NITRATE (NO_3) (mg/l)	MANGANESE (Mn) (mg/l)	PHOSPHATE (PO_4) (mg/l)	BORON (B) (mg/l)	DISSOLVED SOLIDS (Sum) (mg/l)	WATER TYPE (Section 2.4)	HARDNESS AS $CaCO_3$: CALCIUM, MAGNESIUM (mg/l)	HARDNESS AS $CaCO_3$: NON-CARBONATE (mg/l)	SPECIFIC CONDUCTANCE (Micromhos at 25°C)	pH
578	632		385	4.6				2139	SS	188			
		0.8						300	F			484 pts.	
258	0.17		28	6.9				1288	SS				
60	150	5.8	460					1080	SS	120	68	1920	8.1
62 63	152	5.2	445 445	8.0				1060	SS	138	86	1060 1870	
64	151	5.2	450	11.0				1080	SS	148	96	1910	7.1
107 134	124	6.9	236	2.0			10	676	F	76	0	1200 1280	
303 260	34 105	0.4 0.6	32 12	68 35				440 561	F F	164 218		724 880	

3

MANGANESE (Mn) (mg/1)	PHOSPHATE (PO_4) (mg/1)	BORON (B) (mg/1)	DISSOLVED SOLIDS (Sum) (mg/1)	WATER TYPE (Section 2.4)	HARDNESS AS $CaCO_3$: CALCIUM, MAGNESIUM (mg/1)	HARDNESS AS $CaCO_3$: NON-CARBONATE (mg/1)	SPECIFIC CONDUCTANCE (Micromhos at 25°C)	pH	PERCENT SODIUM	REMARKS
										Test well, sealed
										Test well, sealed
			2139	SS	188					Bedrock aquifer Basement (I_1wp)
			300	F			484 pts.			Bedrock aquifer
			1288	SS						
										Bedrock aquifer
										Bedrock (I_{2T})
			1080	SS	120	68	1920	8.3		Volcanic flow rock (I_3
			1060	SS	138	86	1060 1870		84	
			1080	SS	148	96	1910	7.1	83	
		10	676	F	76	0	1200 1280		87	
			440 561	F F	164 218		724 880		57 52	
										Bedrock aquifer

RECORD OF WELLS

WELL NUMBER	WELL LOCATION (TOWNSHIP. RANGE.SECTION)	OWNER	YEAR COMPLETED	WELL SURFACE ELEVATION-FEET (FT.) ABOVE MEAN SEA LEVEL (M.S.L)	COMPLETED DEPTH (FT.)	DIAMETER (IN.) C=DIAMETER CASING	METHOD OF CONSTRUC-TION	TYPE OF PUMP	PERFORATED INTERVAL (FT.)	DEPTH TO ROCK (FT.)	DEPTH
39	8.1.21			2485(est)	170					0	15

	Water level			Pumping data		Chemical analysis									
Depth to rock (ft.)	Depth (ft.)	Date measured	Elevation (ft. above M.S.L.)	Yield / Drawdown (gpm/ft)	Specific capacity (gpm/ft)	Date sampled	Temperature (°C)	Geologic source	Silica (SiO_2) (mg/l)	Iron (Fe) (mg/l)	Calcium (Ca) (mg/l)	Magnesium (Mg) (mg/l)	Sodium and potassium (Na+K) (mg/l)	Bicarbonate (HCO_3) (mg/l)	Sulfate (SO_4) (mg/l)
0	158		2327			9-17		MpЄ	73	3.0	58	51	Na 50	274	3

2

ANALYSIS OF WELL WATER

BICARBONATE (HCO_3) (mg/l)	SULFATE (SO_4) (mg/l)	FLUORIDE (F) (mg/l)	CHLORIDE (Cl) (mg/l)	NITRATE (NO_3) (mg/l)	MANGANESE (Mn) (mg/l)	PHOSPHATE (PO_4) (mg/l)	BORON (B) (mg/l)	DISSOLVED SOLIDS (Sum) (mg/l)	WATER TYPE (Section 2.4)	HARDNESS AS $CaCO_3$		SPECIFIC CONDUCTANCE (Micromhos at 25°C)	pH
										CALCIUM, MANGESIUM (mg/l)	NON-CARBONATE (mg/l)		
274	34		117	26				579	F				

3

MANGANESE (Mn) (mg/l)	PHOSPHATE (PO_4) (mg/l)	BORON (B) (mg/l)	DISSOLVED SOLIDS (Sum) (mg/l)	WATER TYPE (Section 2.4)	HARDNESS AS $CaCO_3$ CALCIUM, MANGESIUM (mg/l)	HARDNESS AS $CaCO_3$ NON-CARBONATE (mg/l)	SPECIFIC CONDUCTANCE (Micromhos at 25°C)	pH	PERCENT SODIUM	REMARKS
			579	F						Bedrock aquifer Basement ($^{M}{}_{PC}$)

LOCATION OF WATER WELLS AND OTHER BORINGS
NOT SHOWN ON FOUR-QUAD OVERLAYS

Number	LOCATION			Remarks
	Township. Range. Section	Valley	4-Quad	
40	6.21.3	Indian Wash Valley-YPG	Y-VI	YPG Well "V" Data available
41	6.22.31	Indian Wash Valley-YPG	Y-VI	YPG Well "X" Data available
42	6.22.31	Indian Wash Valley-YPG	Y-VI	YPG Well "Y" Data available
43	7.21.11	Indian Wash Valley-YPG	Y-VI	YPG Well "U" Data available
44	7.21.33	Indian Wash Valley-YPG	Y-VI	YPG Well Data available
45	6.20.32	Castle Dome Plain-YPG	Y-VI	"New Well" Data available
46	7.21.1	Castle Dome Plain-YPG	Y-VI	"County Well" Data available
47	9.22.28	Yuma Desert LWBGR	Y-V	USGS Well Data available
48	10.23.36	Yuma Desert LWBGR	Y-V	U.S. Bur. of Rec. Well-Data avail.
49	11.22.13	Yuma Desert LWBGR	Y-XII	U.S. Bur. of Rec. Well-Data avail.
50	11.22.24	Yuma Desert LWBGR	Y-XII	U.S. Bur. of Rec. Well-Data avail.
51	11.22.23	Yuma Desert LWBGR	Y-XII	USGS Well Data available
52	12.22.6	Yuma Desert LWBGR	Y-XI	USGS Well Data available
53	12.22.9	Yuma Desert LWBGR	Y-XI	USGS Well Data available
54	9.16.8	Mohawk-Tule Valley-LWBGR	Y-VII	Well No data
55	10.16.21	Mohawk-Tule Valley-LWBGR	Y-VII	"Dry Well" No data
56	8.13.34	San Cristobal Valley-LWBGR	Y-VII	Well No data
57	9.13.12	San Cristobal Valley-LWBGR	Y-VII	Well No data

LOCATION OF WATER WELLS AND OTHER BORINGS
NOT SHOWN ON FOUR-QUAD OVERLAYS

Number	LOCATION Township. Range. Section	Valley	4-Quad	Remarks
58	9.12.28	San Cristobal Valley-LWBGR	Y-VII	"Spains Well" No data
59	11.11.8-9	San Cristobal Valley-LWBGR	Y-XIV	"Well (sealed)" No data
60	10.9.12	Growler-Childs Valley-LWBGR	Y-VIII	"Okie Well" No data
61	10.10.28-29	Growler-Childs Valley-LWBGR	Y-VIII	"Indian Well" No data
62	12.9.16	Growler-Childs Valley-LWBGR	Y-XIV	"Salt Well" No data
63	9.9.4	Sentinel Plain LWBGR	Y-VIII	"Paddit Well" No data
64	8.6.24	Sentinel Plain LWBGR	Y-IX	"Black Gap Well" No data
65	10.5.11	Sentinel Plain LWBGR	Y-IX	"Well that Johnny Dug"-No data
66	10.6.14	Sentinel Plain LWBGR	Y-IX	"Slovan Well" No data
67	7.2.16	Gila Bend Plain LWBGR	Y-X	"Mesquite Well" No data
68	7.2.26	Gila Bend Plain LWBGR	Y-X	"Raleigh Well" No data
69	9.3.3	Gila Bend Plain LWBGR	Y-X	"Platt Well" No data
70	7.1.32	Vekol Valley LWBGR	Y-X	"Javelina Well" No data
71	8.1.22	Vekol Valley LWBGR	Y-X	"Johnson Well" No data
72	9.1.15	Vekol Valley LWBGR	Y-X	"Paradise Well" No data

APPENDIX H

CLIMATOLOGICAL DATA SUMMARY SHEETS

Station: Ajo (#1)   Standard Time Used: Mountain   Latitude: N32°22'

Per.	TEMPERATURE					PRECIPITATION					
	Normals			Extremes							Snow, Ic
	Daily Max. (°F)	Daily Min. (°F)	Mon. (°F)	Rec. High (°F)	Rec. Low (°F)	Norm. Tot. (in.)	Max. Rec. (in.)	Min. Rec. (in.)	Max. - 24 Hrs. (in.)	Mean No. of Days w/Thunder storms	Mean Tot. (in.)
(a)	30	30	30	30	30	30	10	10	30	30	30
J	62.0	40.8	51.4	85	17	0.68	1.09	T	1.46	0	T
F	68.6	43.8	56.2	92	22	0.48	1.46	0.0	1.66	0	T
M	73.4	48.1	60.7	96	27	0.75	1.71	0.0	1.82	1	T
A	87.9	55.6	71.7	103	37	0.23	1.20	0.0	1.44	1	0.0
M	90.6	62.8	76.7	111	38	0.05	1.26	0.0	0.50	1	0.0
J	99.0	71.2	85.1	115	51	0.06	0.50	0.0	0.56	1	0.0
J	103.4	77.1	90.2	115	60	1.33	3.49	0.24	3.17	5	0.0
A	100.7	76.3	88.5	115	57	2.70	4.74	0.31	3.80	4	0.0
S	97.9	72.3	85.1	113	49	0.77	2.91	0.0	4.15	3	0.0
O	87.7	61.3	74.5	106	32	0.52	3.24	0.0	1.89	1	0.0
N	76.8	49.2	63.0	95	30	0.51	2.17	0.01	1.81	0	T
D	65.8	42.5	54.1	86	22	0.78	3.94	0.0	3.00	0	0.21
Yr	84.5	58.4	71.4	115	17	8.86	14.15	5.85	4.15	17	0.21
	(b)	(b)	(b)	(c)	(c)	(d)	(e)	(e)	(c)	(d)	(d)

(a) Years of record.
(b) Average for column.
(c) Extreme for column.
(d) Sum of column.
(e) Annual extreme for period of record.

T = Trace
* = Less than ½

d: Mountain Latitude: N32°22' Longitude: W112°52' Elevation: 1763' (Ground)

PRECIPITATION						RELATIVE HUMIDITY				WIND			
			Snow, Ice Pellets			(Local Time)						Fastest Mile	
Min. Rec. (in.)	Max. - 24 Hrs. (in.)	Mean No. of Days w/Thunder storms	Mean Tot. (in.)	Max. (in.)	Max. - 24 Hrs. (in.)	Hr. 05 (%)	Hr. 11 (%)	Hr. 17 (%)	Hr. 23 (%)	Mean Speed (mph)	Prevail- ing Di- rection	Speed (mph)	Direction (8 Compass Points Only)
10	30	30	30	30									
T	1.46	0	T	1.0									
0.0	1.66	0	T	0.5									
0.0	1.82	1	T	T									
0.0	1.44	1	0.0	T									
0.0	0.50	1	0.0	T									
0.0	0.56	1	0.0	0.0									
0.24	3.17	5	0.0	T									
0.31	3.80	4	0.0	T									
0.0	4.15	3	0.0	T									
0.0	1.89	1	0.0	T									
0.01	1.81	0	T	1.0									
0.0	3.00	0	0.21	3.0									
5.85	4.15	17	0.21	3.0									
(e)	(c)	(d)	(d)	(e)									

han ½

The user of this Climatological Data Summary Sheet is cautioned that conditions at other locations in the siting area may be significantly different because of local terrain effects and differences in elevation.

Station: Blythe Airport (#3)   Standard Time Used: Pacific   Latitude; N33°3

	TEMPERATURE					PRECIPITATION					
	Normals			Extremes							Snow,
Per.	Daily Max. (°F)	Daily Min. (°F)	Mon. (°F)	Rec. High (°F)	Rec. Low (°F)	Norm. Tot. (in.)	Max. Rec. (in.)	Min. Rec. (in.)	Max. - 24 Hrs. (in.)	Mean No. of Days w/Thunder storms	Mean Tot. (in.)
(a)	7	7	30	4	4	30	4	4		30	
J	84	24	53.0		20	0.48	0.63	0.0		0	
F	89	30	57.8			0.24	1.46	0.0		0	
M	92	33	62.7			0.42	0.82	0.0		1	
A	104	45	70.3			0.15	0.05	0.0		1	
M	114	51	77.6			0.02	T	0.0		1	
J	118	59	84.8	122		0.03	0.93	0.0		1	
J	117	72	92.1			0.15	0.10			4	
A	118	65	91.2			0.82	1.35	0.12		3	
S	120	61	85.3			0.20	0.72	0.0		2	
O	105	43	73.7			0.30	2.17	0.0		1	
N	92	33	60.9			0.26	0.54	0.0		0	
D	82	30	53.4			0.43	0.56	0.0		0	
Yr	83	45	71.9	122	20	3.50	3.78	2.29		14	
	(b)	(b)	(b)	(c)	(c)	(d)	(e)	(e)		(d)	

(a) Years of record.
(b) Average for column.
(c) Extreme for column.
(d) Sum of column.
(e) Annual extreme for period of record.

T = Trace
* = Less than ½

d: Pacific Latitude: N33°37' Longitude: W114°36' Elevation: 268' (Ground)

PRECIPITATION						RELATIVE HUMIDITY				WIND			
			Snow, Ice Pellets			(Local Time)						Fastest Mile	
Min. Prec. (in.)	Max. - 24 Hrs. (in.)	Mean No. of Days w/Thunder storms	Mean Tot. (in.)	Max. (in.)	Max. - 24 Hrs. (in.)	Hr. 05 (%)	Hr. 11 (%)	Hr. 17 (%)	Hr. 23 (%)	Mean Speed (mph)	Prevail-ing Di-rection	Speed (mph)	Direction (8 Compass Points Only)
4		30								7	7	7	7
0.0		0								7.2	NNW		
0.0		0								7.3	NNW		
0.0		1								8.4	NSW		
0.0		1								7.9	SSE		
0.0		1								8.8	S		
0.0		1								8.9	SSE		
		4								9.4	SSE		
0.12		3								8.4	SSE		
0.0		2								6.4	S		
0.0		1								6.1	N		
0.0		0								6.7	NNW		
0.0		0								6.9	NNW		
2.29		14								7.7	SSE	48	NNW
(e)		(d)								(b)		(e)	

an ½

The user of this Climatological Data Summary Sheet is cautioned that conditions at other locations in the siting area may be significantly different because of local terrain effects and differences in elevation.

1 2

Station: Casa Grande (#5) Standard Time Used: Mountain Latitude: N32°53'

	TEMPERATURE					PRECIPITATION						
	Normals			Extremes							Snow, Ice	
Per.	Daily Max. (°F)	Daily Min. (°F)	Mon. (°F)	Rec. High (°F)	Rec. Low (°F)	Norm. Tot. (in.)	Max. Rec. (in.)	Min. Rec. (in.)	Max. - 24 Hrs. (in.)	Mean No. of Days w/Thunder storms	Mean Tot. (in.)	Ma (i
(a)	30	30	30	40	40	30	40	40	40	30	30	4
J	66.0	35.0	50.5	88	17	0.74	2.41	0.0	1.14	0	T	3.
F	71.1	38.8	55.0	91	17	0.68	3.51	0.0	1.15	1	0.0	0.
M	76.1	43.0	59.6	101	25	0.71	2.70	0.0	1.13	1	T	T
A	85.4	49.6	67.5	105	31	0.36	2.07	0.0	1.10	1	T	T
M	94.7	57.5	76.2	115	38	0.11	0.86	0.0	0.77	1	0.0	0.
J	103.3	66.3	84.8	118	46	0.16	1.00	0.0	1.12	1	T	T
J	106.2	76.0	91.1	120	56	0.95	5.75	0.06	4.50	5	0.0	0.
A	103.3	74.5	88.9	119	57	1.56	6.22	0.11	3.42	4	T	T
S	99.9	67.2	83.6	116	45	0.79	5.35	0.0	2.92	3	0.0	0.
O	89.5	54.4	72.0	107	29	0.62	5.08	0.0	1.84	1	0.0	0.
N	76.4	42.5	59.5	96	22	0.56	2.95	0.0	1.44	0	0.0	0.
D	67.4	36.2	51.8	87	15	0.88	4.71	0.0	1.65	0	0.0	0.
Yr	86.6	53.4	70.0	120	15	8.12	15.05	3.84	4.50	18	T	3.
	(b)	(b)	(b)	(c)	(c)	(d)	(e)	(e)	(c)	(d)	(d)	(e

(a) Years of record.
(b) Average for column.
(c) Extreme for column.
(d) Sum of column.
(e) Annual extreme for period of record.

T = Trace
* = Less than ½

ed: Mountain Latitude: N32°53' Longitude: W111°45' Elevation: 1405' (Ground)

PRECIPITATION						RELATIVE HUMIDITY				WIND			
			Snow, Ice Pellets			(Local Time)						Fastest Mile	
Min. Rec. (in.)	Max. - 24 Hrs. (in.)	Mean No. of Days w/Thunder storms	Mean Tot. (in.)	Max. (in.)	Max. - 24 Hrs. (in.)	Hr. 05 (%)	Hr. 11 (%)	Hr. 17 (%)	Hr. 23 (%)	Mean Speed (mph)	Prevail-ing Di-rection	Speed (mph)	Direction (8 Compass Points Only)
40	40	30	30	40									
0.0	1.14	0	T	3.0									
0.0	1.15	1	0.0	0.0									
0.0	1.13	1	T	T									
0.0	1.10	1	T	T									
0.0	0.77	1	0.0	0.0									
0.0	1.12	1	T	T									
0.06	4.50	5	0.0	0.0									
0.11	3.42	4	T	T									
0.0	2.92	3	0.0	0.0									
0.0	1.84	1	0.0	0.0									
0.0	1.44	0	0.0	0.0									
0.0	1.65	0	0.0	0.0									
3.84	4.50	18	T	3.0									
(e)	(c)	(d)	(d)	(e)									

than ½

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Station: Gila Bend (#8) Standard Time Used: Mountain Latitude: N3

	TEMPERATURE					PRECIPITATION					
	Normals			Extremes							Sn
Per.	Daily Max. (°F)	Daily Min. (°F)	Mon. (°F)	Rec. High (°F)	Rec. Low (°F)	Norm. Tot. (in.)	Max. Rec. (in.)	Min. Rec. (in.)	Max. - 24 Hrs. (in.)	Mean No. of Days w/Thunder storms	Me To (i
(a)	29	29	29	81	81	29	10	10	81	30	81
J	67.7	37.0	52.4	90	10	0.59	1.39	0.0	1.82	0	T
F	73.3	40.5	56.9	95	23	0.36	1.83	0.0	1.07	0	T
M	78.5	45.0	61.8	100	25	0.52	2.36	0.0	1.30	1	0.
A	87.7	51.8	69.8	108	30	0.20	1.89	0.0	1.38	1	0.
M	96.3	59.5	77.9	116	39	0.08	0.82	0.0	1.25	1	0.
J	104.6	67.5	86.1	121	42	0.05	0.59	0.0	0.70	1	0.
J	109.1	77.7	93.4	123	47	0.74	0.94	T	1.50	6	0.
A	106.8	76.5	91.7	120	54	1.11	2.63	0.10	2.61	3	0.
S	103.3	69.5	86.4	120	41	0.51	2.15	0.0	2.52	3	0.
O	91.8	57.3	74.6	109	31	0.40	2.02	0.0	1.55	1	0.
N	77.4	45.0	61.2	99	22	0.36	1.51	0.0	2.00	0	0.
D	68.9	38.4	53.6	90	15	0.55	3.42	0.0	2.04	0	T
Yr	88.8	51.7	70.3	123	10	5.47	10.01	4.20	2.61	17	T
	(b)	(b)	(b)	(c)	(c)	(d)	(e)	(e)	(c)	(d)	(d)

(a) Years of record.
(b) Average for column.
(c) Extreme for column.
(d) Sum of column.
(e) Annual extreme for period of record.

T = Trace
* = Less than ½

Mountain   Latitude: N32°57'   Longitude: W112°43'   Elevation: 737' (Ground)

PRECIPITATION					RELATIVE HUMIDITY				WIND			
		Snow, Ice Pellets			(Local Time)						Fastest Mile	
Max. - 24 Hrs. (in.)	Mean No. of Days w/Thunder storms	Mean Tot. (in.)	Max. (in.)	Max. - 24 Hrs. (in.)	Hr. 05 (%)	Hr. 11 (%)	Hr. 17 (%)	Hr. 23 (%)	Mean Speed (mph)	Prevail-ing Di-rection	Speed (mph)	Direction (8 Compass Points Only)
81	30	81	81									
1.82	0	T	2.0									
1.07	0	T	0.1									
1.30	1	0.0	0.0									
1.38	1	0.0	0.0									
1.25	1	0.0	0.0									
0.70	1	0.0	0.0									
1.50	6	0.0	0.0									
2.61	3	0.0	0.0									
2.52	3	0.0	0.0									
1.55	1	0.0	0.0									
2.00	0	0.0	0.0									
2.04	0	T	2.5									
2.61	17	T	2.5									
(c)	(d)	(d)	(e)									

The user of this Climatological Data Summary Sheet is cautioned that conditions at other locations in the siting area may be significantly different because of local terrain effects and differences in elevation.

Station: Phoenix (#14) Standard Time Used: Mountain Latitude: N3

	TEMPERATURE					PRECIPITATION					
	Normals			Extremes							Sno
Per.	Daily Max. (°F)	Daily Min. (°F)	Mon. (°F)	Rec. High (°F)	Rec. Low (°F)	Norm. Tot. (in.)	Max. Rec. (in.)	Min. Rec. (in.)	Max. - 24 Hrs. (in.)	Mean No. of Days w/Thunder storms	Me To (i
(a)	40	40	40	40	40	40	70	70	37	34	40
J	65.0	38.1	51.6	88	16	0.75	3.31	0.00	1.31	*	T
F	69.1	41.8	55.5	89	22	0.73	4.64	0.00	1.07	1	T
M	74.7	46.1	60.4	95	25	0.76	4.16	0.00	1.32	1	0.0
A	83.0	52.4	67.7	104	32	0.35	3.36	0.00	1.38	1	T
M	91.9	59.9	75.9	113	40	0.14	1.31	0.00	0.94	1	0.0
J	101.4	68.7	85.1	117	50	0.12	1.70	0.00	1.64	1	0.0
J	104.1	77.4	90.8	118	61	0.91	6.47	T	4.98	6	0.0
A	101.8	76.0	88.9	116	60	1.22	5.56	T	3.07	8	0.0
S	97.7	69.1	83.4	118	47	0.78	4.23	0.00	2.43	3	0.0
O	86.8	56.4	71.6	104	34	0.49	4.40	0.00	2.27	1	0.0
N	74.6	45.0	59.8	92	25	0.61	3.61	0.00	1.07	1	0.0
D	65.8	38.9	52.4	88	22	0.88	3.98	0.00	1.89	1	T
Yr	84.7	55.8	70.3	118	16	7.44	19.73	2.82	4.98	23	T
	(b)	(b)	(b)	(c)	(c)	(d)	(e)	(e)	(c)	(d)	(d)

(a) Years of record.
(b) Average for column.
(c) Extreme for column.
(d) Sum of column
(e) Annual extreme for period of record.

T = Trace
* = Less than ½.

/ N

Used: Mountain Latitude: N33°26' Longitude: W112°01' Elevation: 1117' (Ground)

PRECIPITATION						RELATIVE HUMIDITY				WIND			
			Snow, Ice Pellets			(Local Time)						Fastest Mile	
Min. Rec. (in.)	Max. - 24 Hrs. (in.)	Mean No. of Days w/Thunder storms	Mean Tot. (in.)	Max. (in.)	Max. - 24 Hrs. (in.)	Hr. 05 (%)	Hr. 11 (%)	Hr. 17 (%)	Hr. 23 (%)	Mean Speed (mph)	Prevail-ing Di-rection	Speed (mph)	Direction (8 Compass Points Only)
70	37	34	40	70	36	13	13	13	13	28	18	36	36
0.00	1.31	*	T	1.0	1.0	67	44	30	56	5.0	E	49	WNW
0.00	1.07	1	T	0.6	0.6	60	38	26	49	5.6	E	49	SSE
0.00	1.32	1	0.0	0.2	0.0	58	33	23	44	6.3	E	50	WNW
0.00	1.38	1	T	T	T	44	23	16	29	6.7	E	45	NW
0.00	0.94	1	0.0	T	0.0	36	18	13	22	6.7	E	59	SSE
0.00	1.64	1	0.0	0.0	0.0	36	18	13	23	6.7		59	S
T	4.98	6	0.0	0.0	0.0	46	28	20	33	6.9	W	71	N
T	3.07	8	0.0	0.0	0.0	55	35	24	41	6.4	E	60	SSW
0.00	2.43	3	0.0	0.0	0.0	53	32	23	41	6.1	E	75	SW
0.00	2.27	1	0.0	0.0	0.0	53	29	21	42	5.6	E	48	SSW
0.00	1.07	1	0.0	0.1	0.0	61	38	29	53	5.1	E	45	WSW
0.00	1.89	1	T	T	T	69	48	35	60	4.9	E	68	W
2.82	4.98	23	T	1.0	1.0	53	32	23	41	6.0	E	75	SW
(e)	(c)	(d)	(d)	(e)	(e)	(b)	(b)	(b)	(b)	(b)		(c)	

than ½.

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Station: Salome (#16) Standard Time Used: Mountain Latitude: N33°47'
N33°47'

	TEMPERATURE					PRECIPITATION						
	Normals			Extremes							Snow, Ice Pe	
Per.	Daily Max. (°F)	Daily Min. (°F)	Mon. (°F)	Rec. High (°F)	Rec. Low (°F)	Norm. Tot. (in.)	Max. Rec. (in.)	Min. Rec. (in.)	Max. - 24 Hrs. (in.)	Mean No. of Days w/Thunder storms	Mean Tot. (in.)	Max. (in.
(a)	14	14	14	13	12	12	14	14	13	30	12	14
J	63.9	31.7	47.8	83	13	0.66	1.87	0.0	1.20	0	T	0.5
F	67.6	35.4	51.5	89	11	0.70	1.39	0.0	1.07	0	0.0	0.0
M	72.9	38.0	55.5	93	10	0.45	1.24	0.0	0.51	1	0.0	0.0
A	81.4	44.8	63.1	99	29	0.49	3.06	0.0	1.52	1	0.0	0.0
M	90.8	53.0	71.9	107	34	0.12	0.41	0.0	0.23	1	0.0	0.0
J	99.5	61.2	80.4	117	45	0.10	0.51	0.0	0.51	1	0.0	0.0
J	104.6	71.1	87.9	115	53	0.85	2.43	0.0	1.75	4	0.0	0.0
A	102.6	70.6	86.6	112	51	1.37	4.01	0.13	1.20	3	0.0	0.0
S	97.7	62.5	80.1	110	46	0.48	2.46	0.0	2.40	3	0.0	0.0
O	87.5	50.3	68.9	104	33	0.50	2.16	0.0	1.42	1	0.0	
N	73.5	40.1	56.8	92	25	0.51	1.60	0.0	1.25	0	0.1	1.5
D	64.0	32.4	48.2	80	11	0.86	2.44	0.0	1.26	0	0.4	5.0
Yr	83.8	49.3	66.6	117	10	7.09	13.45	3.70	2.40	15	0.5	5.0
	(b)	(b)	(b)	(c)	(c)	(d)	(e)	(e)	(c)	(d)	(d)	(e)

(a) Years of record.
(b) Average for column.
(c) Extreme for column.
(d) Sum of column.
(e) Annual extreme for period of record.

T = Trace
* = Less than ½

sed: Mountain Latitude: N33°47' N33°47' Longitude: W113°37' Elevation: 1900' (Ground)

PRECIPITATION						RELATIVE HUMIDITY				WIND			
			Snow, Ice Pellets			(Local Time)						Fastest Mile	
Min. Rec. (in.)	Max. - 24 Hrs. (in.)	Mean No. of Days w/Thunder storms	Mean Tot. (in.)	Max. (in.)	Max. - 24 Hrs. (in.)	Hr. 05 (%)	Hr. 11 (%)	Hr. 17 (%)	Hr. 23 (%)	Mean Speed (mph)	Prevail-ing Di-rection	Speed (mph)	Direction (8 Compass Points Only)
14	13	30	12	14									
0.0	1.20	0	T	0.5									
0.0	1.07	0	0.0	0.0									
0.0	0.51	1	0.0	0.0									
0.0	1.52	1	0.0	0.0									
0.0	0.23	1	0.0	0.0									
0.0	0.51	1	0.0	0.0									
0.0	1.75	4	0.0	0.0									
0.13	1.20	3	0.0	0.0									
0.0	2.40	3	0.0	0.0									
0.0	1.42	1	0.0										
0.0	1.25	0	0.1	1.5									
0.0	1.26	0	0.4	5.0									
3.70	2.40	15	0.5	5.0									
(e)	(c)	(d)	(d)	(e)									

than ½

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Station: Tucson (#19) Standard Time Used: Mountain Latitude: N32°07'

Per.	TEMPERATURE					PRECIPITATION						
	Normals			Extremes							Snow, Ic	
	Daily Max. (°F)	Daily Min. (°F)	Mon. (°F)	Rec. High (°F)	Rec. Low (°F)	Norm. Tot. (in.)	Max. Rec. (in.)	Max. Rec. (in.)	Max. - 24 Hrs. (in.)	Mean No. of Days w/Thunder storms	Mean Tot. (in.)	M (
(a)	61	61	61	40	40	40	70	70	33	33	33	33
J	64.6	35.7	50.2	87	6	0.77	2.37	0.00	1.40	*	0.3	4.
F	67.6	38.3	53.0	92	20	0.82	4.15	0.00	1.49	*	0.2	3.
M	73.3	42.2	57.8	92	20	0.71	3.88	0.00	1.19	*	0.3	5.
A	81.0	47.9	64.5	102	27	0.36	3.53	0.00	0.75	1	T	1.
M	89.6	55.2	72.4	107	38	0.19	1.34	0.00	0.89	1	0.0	0.
J	99.0	64.8	81.9	112	47	0.27	2.07	0.00	1.27	2	0.0	0.
J	99.4	72.7	86.1	111	63	2.38	5.53	0.25	3.93	14	0.0	0.
A	96.9	71.1	84.0	109	61	2.34	7.93	0.08	2.48	14	0.0	0.
S	94.7	65.5	80.1	107	44	1.37	5.11	0.00	3.05	5	0.0	0.
O	85.4	53.3	69.4	101	26	0.66	4.51	0.00	1.86	2	T	T
N	73.5	42.5	58.0	90	24	0.78	4.61	0.00	1.86	*	0.2	6.
D	65.6	36.7	51.2	84	18	1.03	5.85	0.00	1.54	*	0.4	6.
Yr	82.6	52.2	67.4	112	6	11.20	24.17	5.16	3.93	40	1.4	6.
	(b)	(b)	(b)	(c)	(c)	(d)	(e)	(e)	(c)	(d)	(d)	(e)

(a) Years of record.
(b) Average for column.
(c) Extreme for column.
(d) Sum of column.
(e) Annual extreme for period of record.

T = Trace
* = Less than ½

sed: Mountain   Latitude: N32°07'   Longitude: W110°56'   Elevation: 2384' (Ground)

PRECIPITATION						RELATIVE HUMIDITY				WIND			
			Snow, Ice Pellets			(Local Time)						Fastest Mile	
Max. Rec. (in.)	Max. - 24 Hrs. (in.)	Mean No. of Days w/Thunder storms	Mean Tot. (in.)	Max. (in.)	Max. - 24 Hrs. (in.)	Hr. 05 (%)	Hr. 11 (%)	Hr. 17 (%)	Hr. 23 (%)	Mean Speed (mph)	Prevail- ing Di- rection	Speed (mph)	Direction (8 Compass Points Only)
70	33	33	33	33	32	33	33	33	33	28	15	26	29
0.00	1.40	*	0.3	4.7	3.5	62	39	32	56	7.9	SE	40	E
0.00	1.49	*	0.2	3.9	3.5	58	34	27	49	8.1	SE	59	E
0.00	1.19	*	0.3	5.7	5.7	52	28	22	42	8.5	SE	41	SE
0.00	0.75	1	T	1.0	1.0	42	21	10	31	8.8	SE	46	SE
0.00	0.89	1	0.0	0.0	0.0	33	16	12	24	8.6	SE	42	NE
0.00	1.27	2	0.0	0.0	0.0	33	17	13	24	8.5	SSE	50	SE
0.25	3.93	14	0.0	0.0	0.0	57	33	28	47	8.2	SE	71	SE
0.08	2.48	14	0.0	0.0	0.0	67	39	34	55	7.6	SE	54	NE
0.00	3.05	5	0.0	0.0	0.0	54	31	26	44	8.1	SE	54	SE
0.00	1.86	2	T	T	T	52	29	25	43	8.2	SE	47	SE
0.00	1.86	*	0.2	6.4	6.4	54	32	28	48	8.0	SE	55	E
0.00	1.54	*	0.4	6.8	6.8	62	39	35	56	7.8	SE	44	W
5.16	3.93	40	1.4	6.8	6.8	52	30	25	43	8.2	SE	71	SE
(e)	(c)	(d)	(d)	(e)	(e)	(b)	(b)	(b)	(b)	(b)		(c)	

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Station: Wellton (#20)　　Standard Time Used: Mountain　　Latitude:

	TEMPERATURE					PRECIPITATION				
	Normals			Extremes						
Per.	Daily Max. (°F)	Daily Min. (°F)	Mon. (°F)	Rec. High (°F)	Rec. Low (°F)	Norm. Tot. (in.)	Max. Rec. (in.)	Min. Rec. (in.)	Max. - 24 Hrs. (in.)	Mean No. of Days w/Thunder storms
(a)	30	30	30	50	50	30	10	10	50	30
J	68	34	51	89	14	0.36	0.85	0.0	1.07	0
F	73	39	56	90	14	0.47	1.50	0.0	1.91	0
M	76	45	61	100	20	0.21	1.70	0.0	1.27	1
A	86	50	68	105	31	0.10	1.30	0.0	1.00	1
M	93	57	75	114	40	0.01	0.24	0.0	0.41	1
J	101	63	82	120	47	0.02	0.53	0.0	0.53	1
J	106	76	91	121	54	0.32	1.40	0.0	1.42	3
A	105	76	90	120	55	0.77	1.56	T	1.48	3
S	100	68	84	118	42	0.52	4.39	0.0	3.25	3
O	90	55	73	108	32	0.39	3.11	0.0	2.23	1
N	77	41	59	96	19	0.27	1.64	0.0	1.23	0
D	68	35	51	86	16	0.41	2.44	0.0	2.19	0
Yr	87	53	70	121	14	3.84	6.88	1.69	3.25	14
	(b)	(b)	(b)	(c)	(c)	(d)	(e)	(e)	(c)	(d)

(a) Years of record.
(b) Average for column.
(c) Extreme for column.
(d) Sum of column.
(e) Annual extreme for period of record.

T = Trace
* = Less than ½

d: Mountain Latitude: N32°40' Longitude: W114°08' Elevation: 260' (Ground)

PRECIPITATION						RELATIVE HUMIDITY				WIND			
			Snow, Ice Pellets			(Local Time)						Fastest Mile	
Min. Rec. (in.)	Max. - 24 Hrs. (in.)	Mean No. of Days w/Thunder storms	Mean Tot. (in.)	Max. (in.)	Max. - 24 Hrs. (in.)	Hr. 05 (%)	Hr. 11 (%)	Hr. 17 (%)	Hr. 23 (%)	Mean Speed (mph)	Prevail-ing Di-rection	Speed (mph)	Direction (8 Compass Points Only)
10	50	30	30	50									
0.0	1.07	0	T	T									
0.0	1.91	0	0.0	0.0									
0.0	1.27	1	0.0	0.0									
0.0	1.00	1	0.0	0.0									
0.0	0.41	1	0.0	0.0									
0.0	0.53	1	0.0	0.0									
0.0	1.42	3	0.0	0.0									
T	1.48	3	0.0	0.0									
0.0	3.25	3	0.0	0.0									
0.0	2.23	1	0.0	0.0									
0.0	1.23	0	0.0	0.0									
0.0	2.19	0	0.0	0.0									
1.69	3.25	14	T	T									
(e)	(c)	(d)	(d)	(e)									

han ½

The user of this Climatological Data Summary Sheet is cautioned that conditions at other locations in the siting area may be significantly different because of local terrain effects and differences in elevation.

2

N

Station: Yuma, Arizona (#21) Standard Time Used: MST Latitude:

Per.	TEMPERATURE					PRECIPITATION					
	Normals			Extremes							Snow,
	Daily Max. (°F)	Daily Min. (°F)	Mon. (°F)	Rec. High (°F)	Rec. Low (°F)	Norm. Tot. (in.)	Max. Rec. (in.)	Min. Rec. (in.)	Max.- 24 Hrs. (in.)	Mean No. of Days w/Thunder-storms	Mean Tot. (in.)
(a)	30	30	30	49	49	68	68	68	23	23	23
J	67.2	43.3	55.3	88	22	.44	2.83	.00	.56	0	T
F	72.8	47.4	60.1	94	31	.42	3.43	.00	1.34	*	0.0
M	79.4	51.9	65.7	98	34	.32	3.33	.00	.62	*	0.0
A	87.1	58.4	72.8	107	42	.10	.91	.00	1.08	*	0.0
M	95.4	65.4	80.4	115	46	.03	.90	.00	.37	*	0.0
J	103.0	72.5	87.8	120	54	.01	.62	.00	.26	*	0.0
J	107.7	81.5	94.6	119	63	.21	1.36	.00	1.06	1	T
A	106.1	81.3	93.7	117	63	.57	6.25	.00	4.01	2	T
S	101.7	74.9	88.3	123	53	.39	5.13	.00	2.42	1	T
O	90.2	62.6	76.4	109	35	.30	2.68	.00	2.20	1	T
N	77.4	51.0	64.2	94	30	.22	2.44	.00	1.42	*	0.0
D	68.1	46.0	57.1	86	22	.47	2.58	.00	1.37	*	T
Yr	88.0	61.4	74.7	123	22	3.48	11.41	0.30	4.01	7	T
	(b)	(b)	(b)	(c)	(c)	(d)	(e)	(e)	(c)	(d)	(d)

(a) Years of record.
(b) Average for column.
(c) Extreme for column.
(d) Sum of column.
(e) Annual extreme for period of record.

T = Trace
* = Less than ½

Jsed: MST Latitude: 32°40'N Longitude: 114°36'W Elevation: 199 Ft. (Ground)

'RECIPITATION							RELATIVE HUMIDITY				WIND			
			Snow, Ice Pellets			(Local Time)						Fastest Mile	
in. ec. in.)	Max.- 24 Hrs. (in.)	Mean No. of Days w/Thunder-storms	Mean Tot. (in.)	Max. Mon. (in.)	Max.- 24 Hrs. (in.)	Hr. 05 (%)	Hr. 11 (%)	Hr. 17 (%)	Hr. 23 (%)	Mean Speed (mph)	Prevailing Direction	Speed (mph)	Direction (to 8 Compass Pts. Only)
[illegible]	23	23	23	23	23	13	13	13	13	23	13	23	23
[illegible]	.56	0	T	T	T	53	35	25	46	7.3	N	41	NW
[illegible]	1.34	*	0.0	0.0	0.0	49	29	20	40	7.4	N	50	NW
[illegible]	.62	*	0.0	0.0	0.0	45	25	15	35	7.8	WNW	43	N
[illegible]	1.08	*	0.0	0.0	0.0	43	21	14	32	8.4	W	47	NW
[illegible]	.37	*	0.0	0.0	0.0	39	19	11	28	8.3	WNW	38	NW
[illegible]	.26	*	0.0	0.0	0.0	36	19	12	26	8.4	SSE	42	SW
[illegible]	1.06	1	T	T	T	47	29	20	36	9.4	SSE	52	NE
[illegible]	4.01	2	T	T	T	55	34	25	44	9.0	SSE	60	SE
[illegible]	2.42	1	T	T	T	53	29	20	41	7.1	SSE	42	SE
[illegible]	2.20	1	T	T	T	49	27	19	39	6.4	N	47	S
[illegible]	1.42	*	0.0	0.0	0.0	48	28	22	40	6.7	N	47	N
[illegible]	1.37	*	T	T	T	47	32	25	41	7.2	N	47	W
[illegible]	4.01	7	T	T	T	47	27	19	37	7.8	N	60	SE
[illegible]	(c)	(d)	(d)	(e)	(c)	(b)	(b)	(b)	(b)	(b)		(c)	

an ½

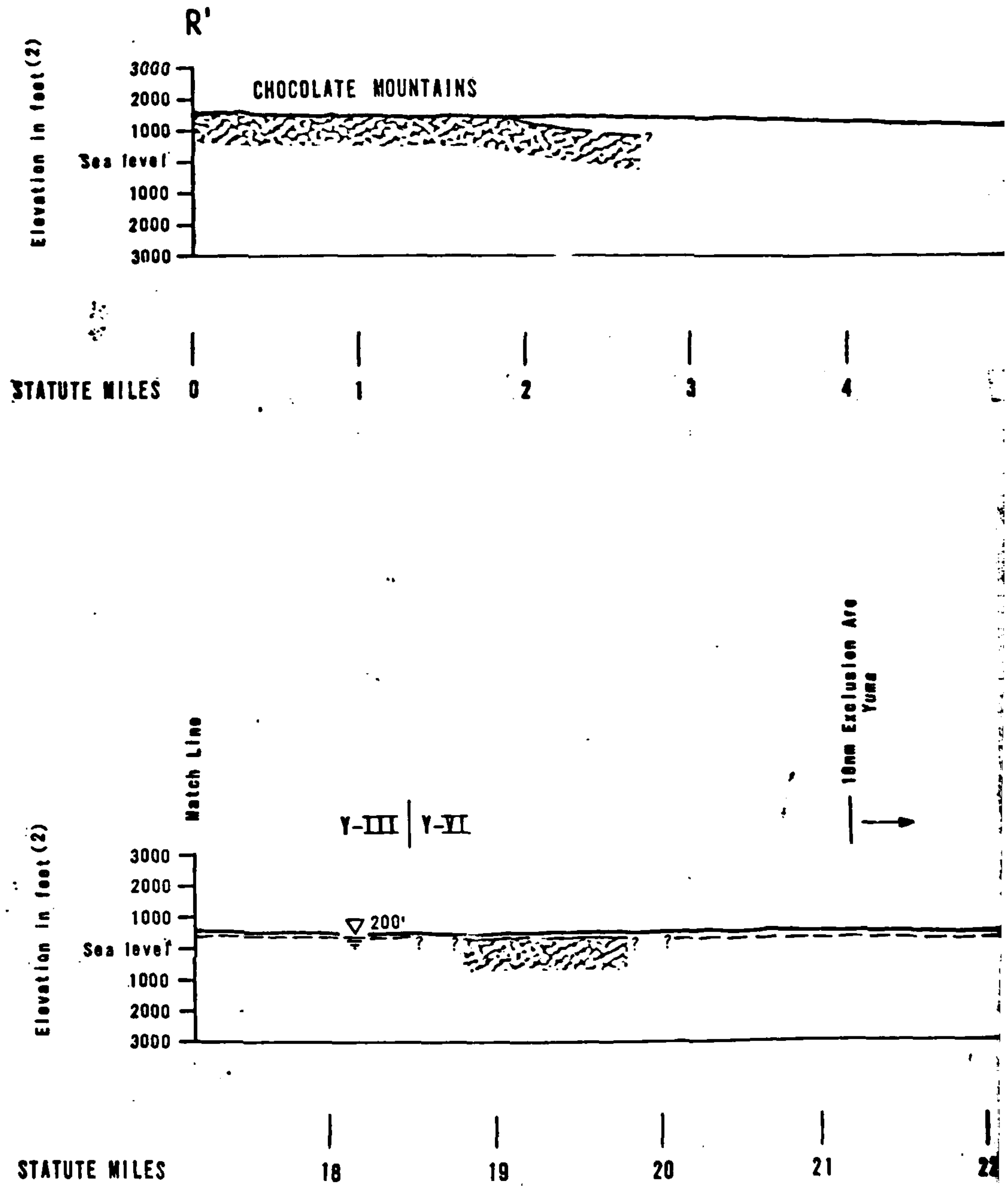
The user of this Climatological Data Summary Sheet is cautioned that conditions at other locations in the siting area may be significantly different because of local terrain effects and differences in elevation.

APPENDIX I

GEOLOGIC SECTIONS

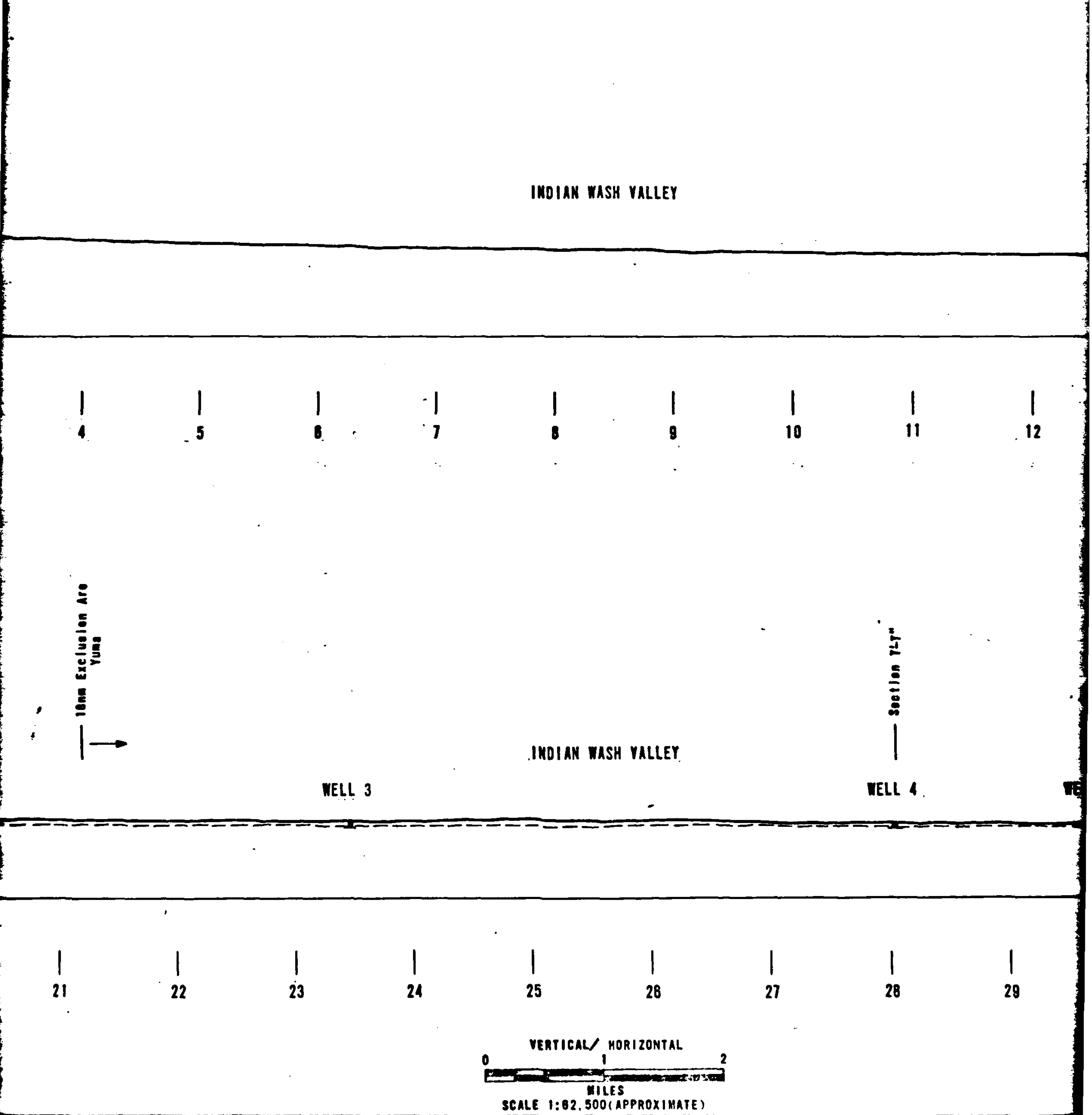
ABBREVIATIONS

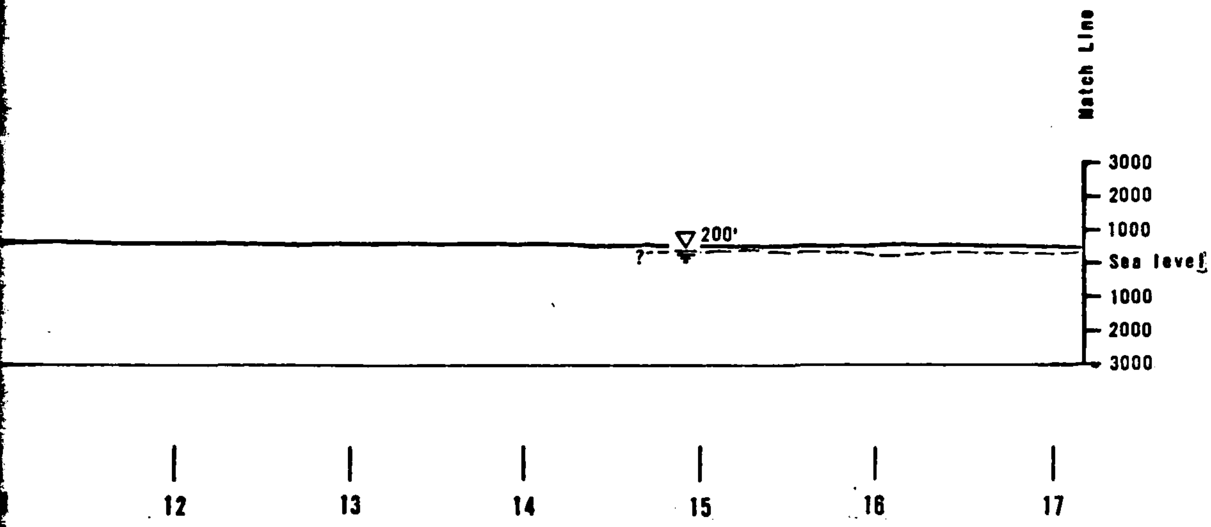
S.E.	Surface Elevation
T.D.	Total Depth



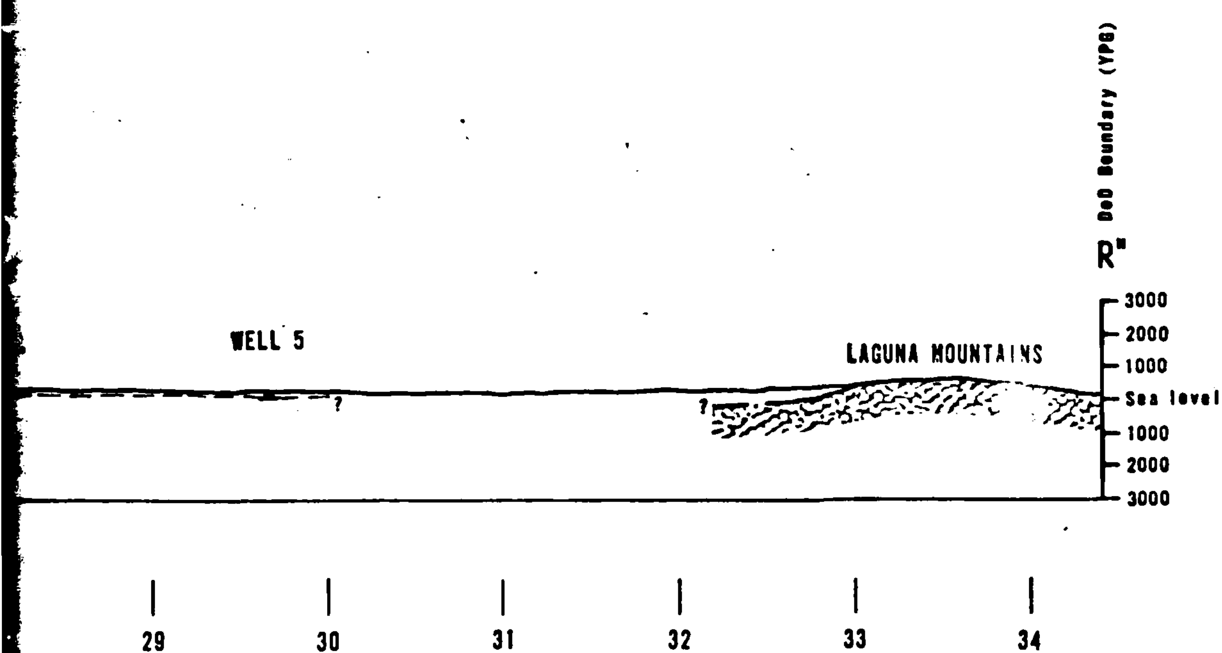
DATE: 30 JUNE 1975

GEOLOGIC SECTION R'-R"(3)



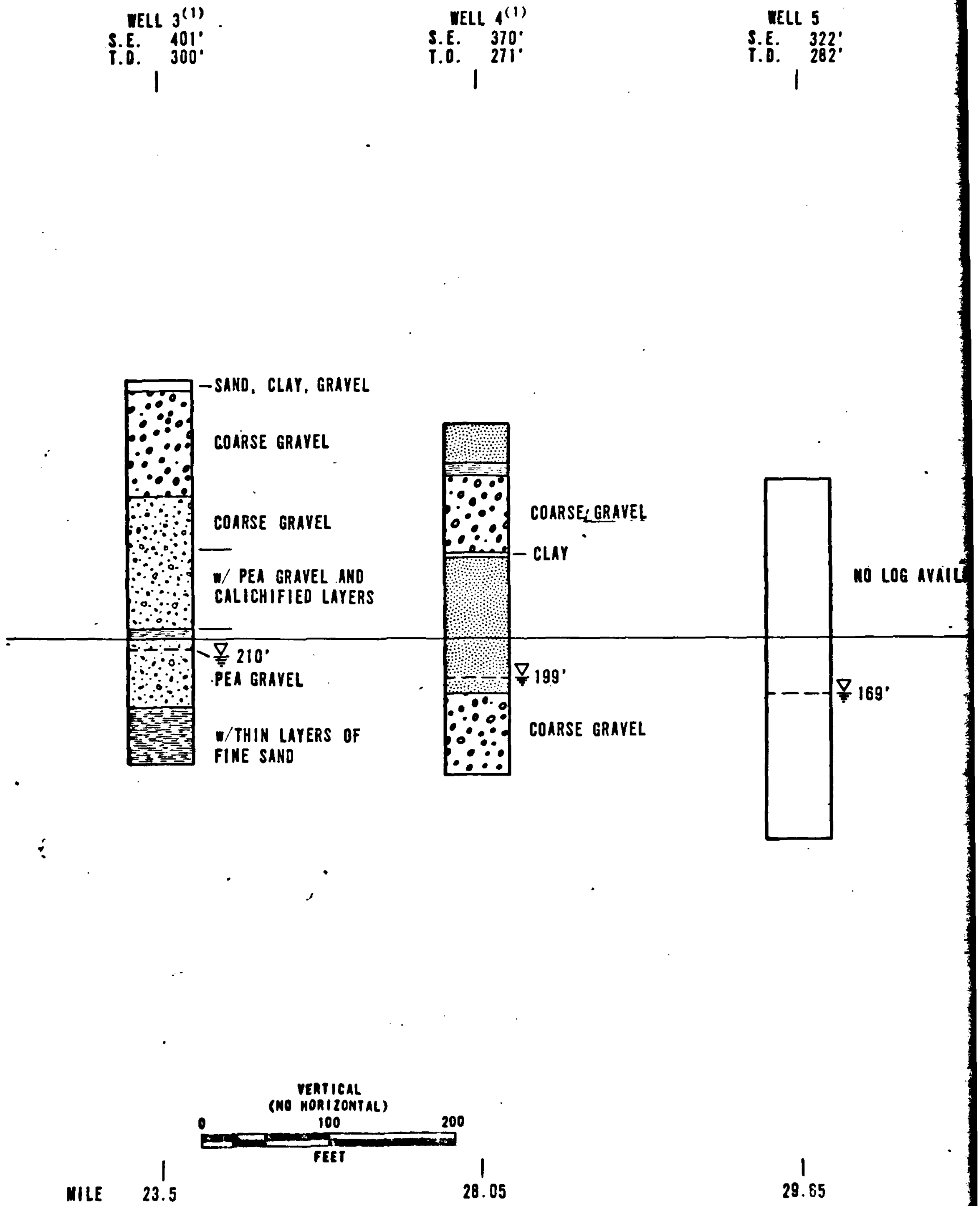


Match Line
200'
3000
2000
1000
Sea level
1000
2000
3000
12
13
14
15
16
17



DoD Boundary (YPG)
R"
WELL 5
LAGUNA MOUNTAINS
3000
2000
1000
Sea level
1000
2000
3000
29
30
31
32
33
34

WELL LOGS



WELL 3(1)
S.E. 401'
T.D. 300'
WELL 4(1)
S.E. 370'
T.D. 271'
WELL 5
S.E. 322'
T.D. 282'
SAND, CLAY, GRAVEL
COARSE GRAVEL
COARSE GRAVEL
w/ PEA GRAVEL AND CALICHIFIED LAYERS
210'
PEA GRAVEL
w/THIN LAYERS OF FINE SAND
COARSE GRAVEL
CLAY
199'
COARSE GRAVEL
NO LOG AVAIL
169'
VERTICAL
(NO HORIZONTAL)
0
100
200
FEET
MILE
23.5
28.05
29.65

ELL 5
322'
282'

NO LOG AVAILABLE

ELEV. 200'(2)

169'

E 85

EXPL

Lithologies shown in well logs represe
material. Appropriate modifiers a

UNDIFFERENTIATED BASIN FILL

GRAVEL AND COARSER GRAINED

SAND AND GRAVEL

SAND

SILT

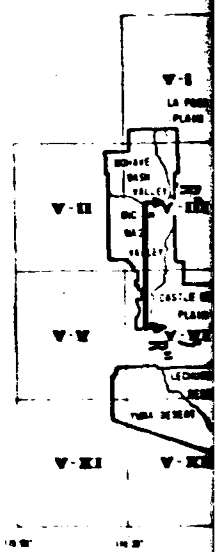
CLAY

CLAY AND SAND

ROCK

VOLCANIC FLOW ROCK

PEDIMENT/PEDIMENT DEPOSITS



NOTES:

(1) DRILLERS LOGS: LITHOLOGIC DESCRIPTIONS SHOULD NOT BE CONSIDERED ACCURATE.
(2) ALL ELEVATIONS ARE RELATIVE TO MEAN SEA LEVEL.
(3) DEPTH TO ROCK UNKNOWN - MILE 2.7 TO 18.8 AND MILE 19.8 TO 32.2

EXPLANATION

Lithologies shown in well logs represent predominant (greater than 70 percent) material. Appropriate modifiers appear to the right of each well log.

UNDIFFERENTIATED BASIN FILL

GRAVEL AND COARSER GRAINED

SAND AND GRAVEL

SAND

SILT

CLAY

CLAY AND SAND

ROCK

VOLCANIC FLOW ROCK

PEDIMENT/PEDIMENT DEPOSITS

GEOLOGIC CONTACT - Solid where data specific; dashed where approximate; queried where extrapolated or questionable.

GROUNDWATER LEVEL - Queried where extrapolated or questionable.

DEPTH TO GROUNDWATER IN BASIN-FILL DEPOSITS - Indicates depth to water in feet (100') where not graphically depicted due to small scale.

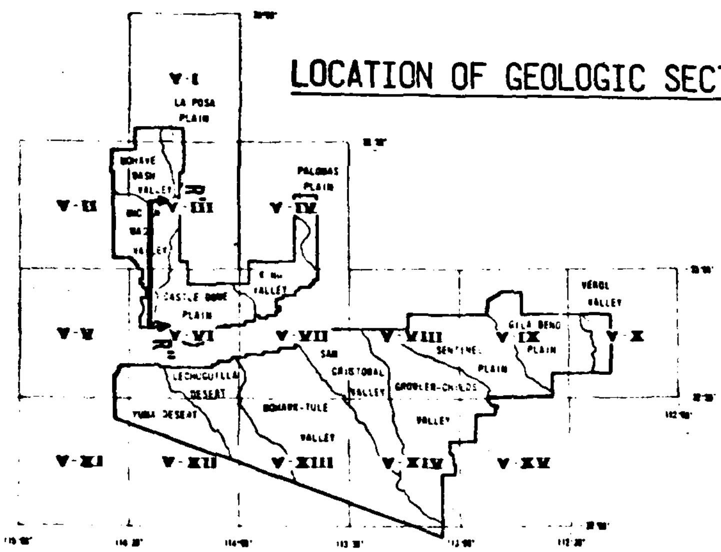
FAULT - Arrows indicate relative movement.

WELL 5
[1000'/ S40E]

WELL - Brackets indicate well projected 1000 feet to geologic section line on azimuth south 40 degrees east.

IC DESCRIPTIONS
ACCURATE.
IVE TO MEAN SEA LEVEL.
MILE 2.7 TO 18.8

LOCATION OF GEOLOGIC SECTION LINE



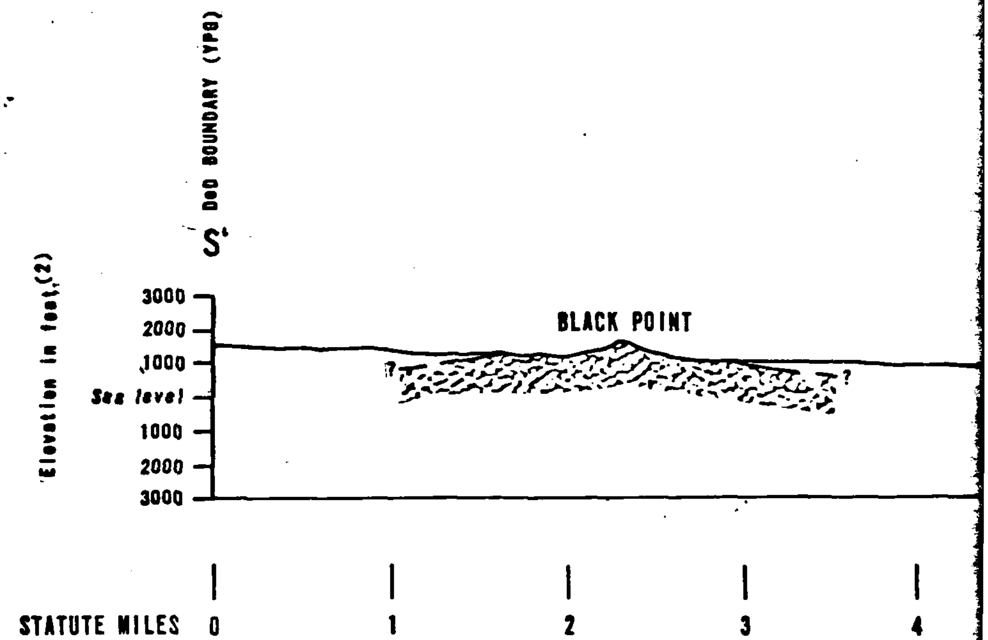
GEOLOGIC SECTION R'-R"

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE 1-2

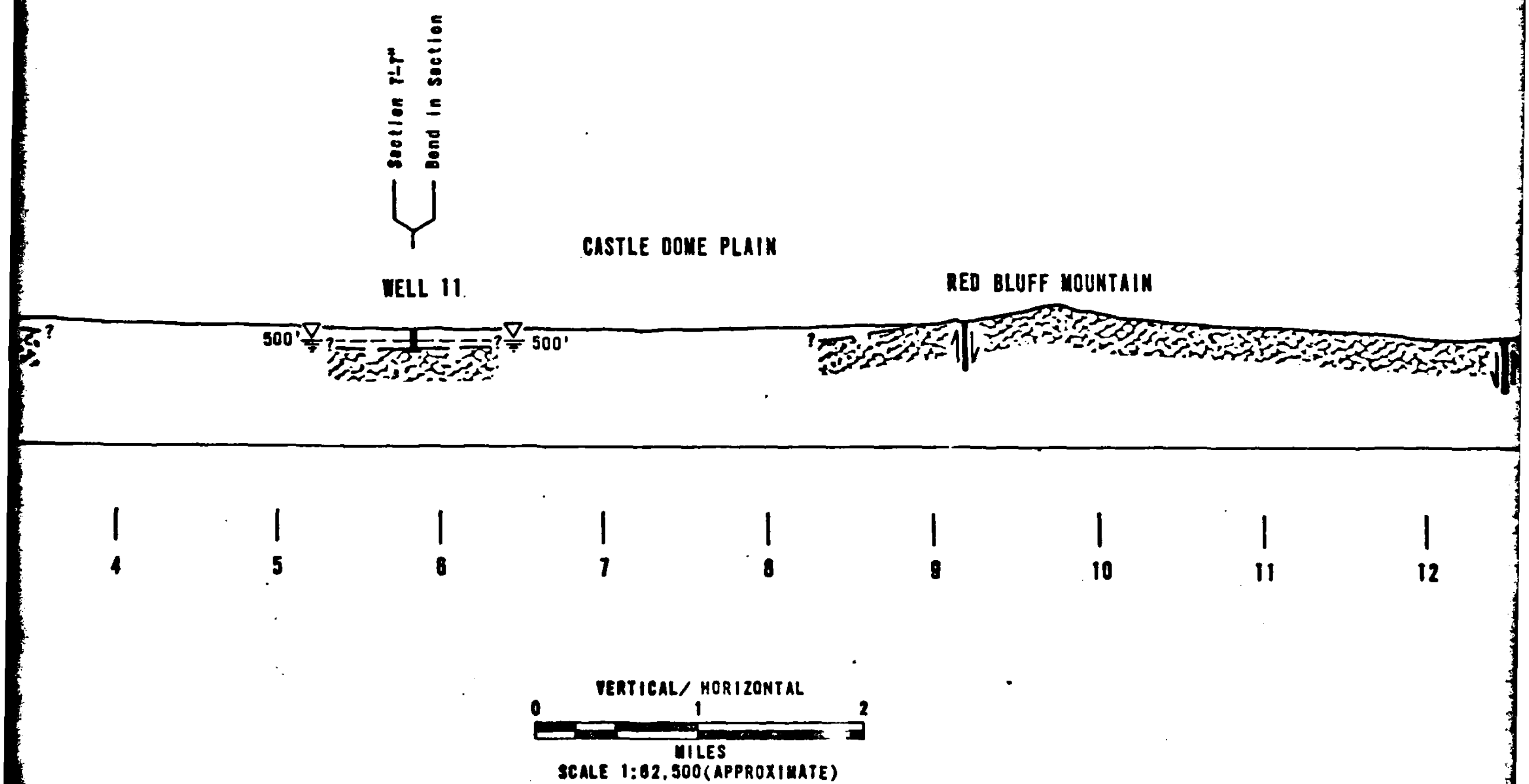
1

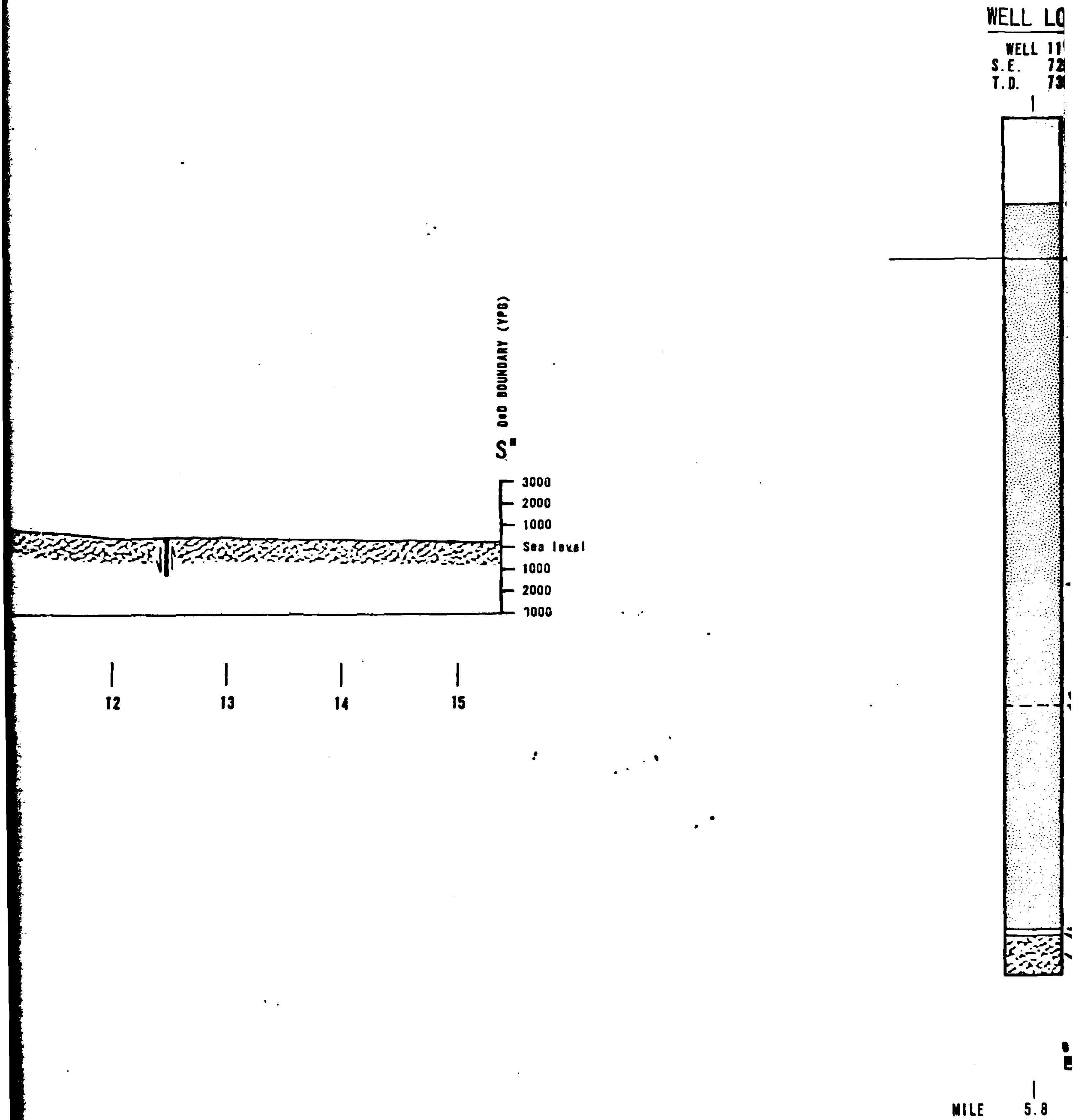
6



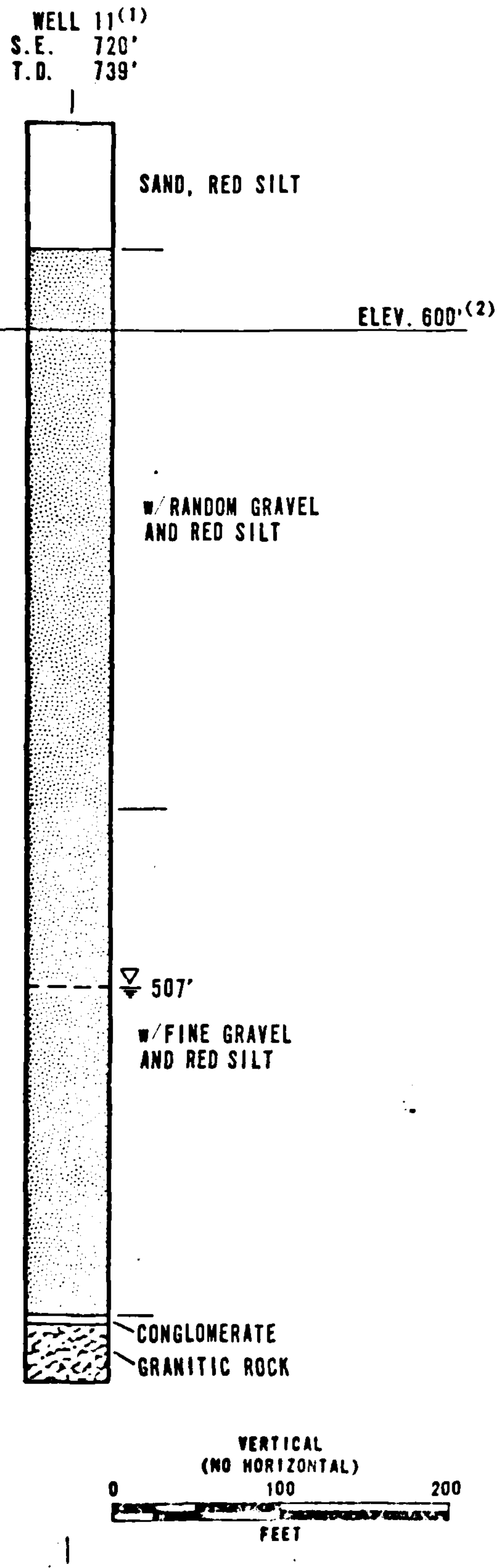
DATE: 30 JUNE 1975

GEOLOGIC SECTION S'-S''[3]

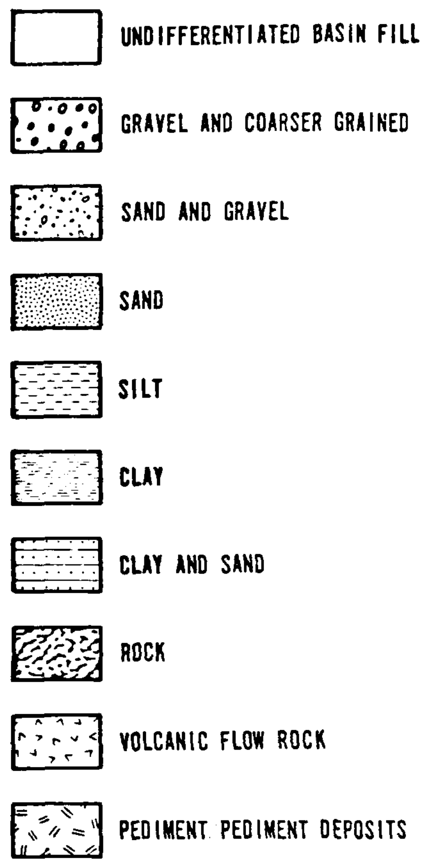



WELL LO
WELL 11
S.E. 72
T.D. 73
S" DoD BOUNDARY (YPG)
3000
2000
1000
Sea level
1000
2000
3000
12
13
14
15
MILE
5.8

WELL LOG



Lithologies shown
material. A



NOTES:

(1) DRILLERS LOGS: LITHOLOGIC DESCRIPTIONS SHOULD NOT BE CONSIDERED ACCURATE.

(2) ALL ELEVATIONS ARE RELATIVE TO MEAN SEA LEVEL.

(3) DEPTH TO ROCK UNKNOWN - MILE 0.0 TO 1.05, MILE 3.5 TO 5.3, AND 6.3 TO 8.3

LE 5.8

EXPLANATION

Lithologies shown in well logs represent predominant (greater than 70 percent) material. Appropriate modifiers appear to the right of each well log.

- UNDIFFERENTIATED BASIN FILL
- GRAVEL AND COARSER GRAINED
- SAND AND GRAVEL
- SAND
- SILT
- CLAY
- CLAY AND SAND
- ROCK
- VOLCANIC FLOW ROCK
- PEDIMENT PEDIMENT DEPOSITS

GEOLOGIC CONTACT – Solid where data specific; dashed where approximate; queried where extrapolated or questionable.

250' GROUNDWATER LEVEL – Queried where extrapolated or questionable.

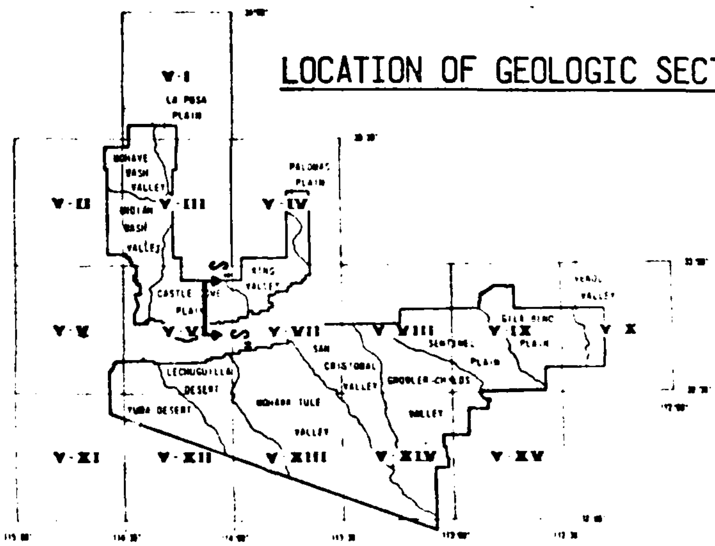
100' DEPTH TO GROUNDWATER IN BASIN-FILL DEPOSITS – Indicates depth to water in feet (100') where not graphically depicted due to small scale.

FAULT – Arrows indicate relative movement.

WELL 5
[1000'/ S40E]

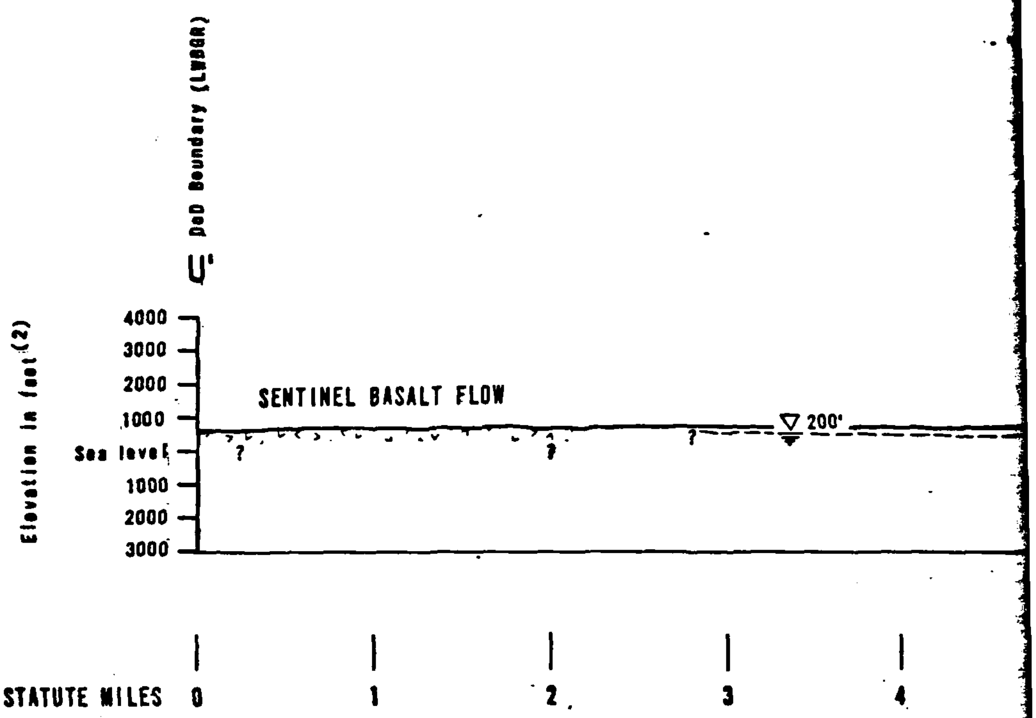
WELL – Brackets indicate well projected 1000 feet to geologic section line on azimuth south 40 degrees east.

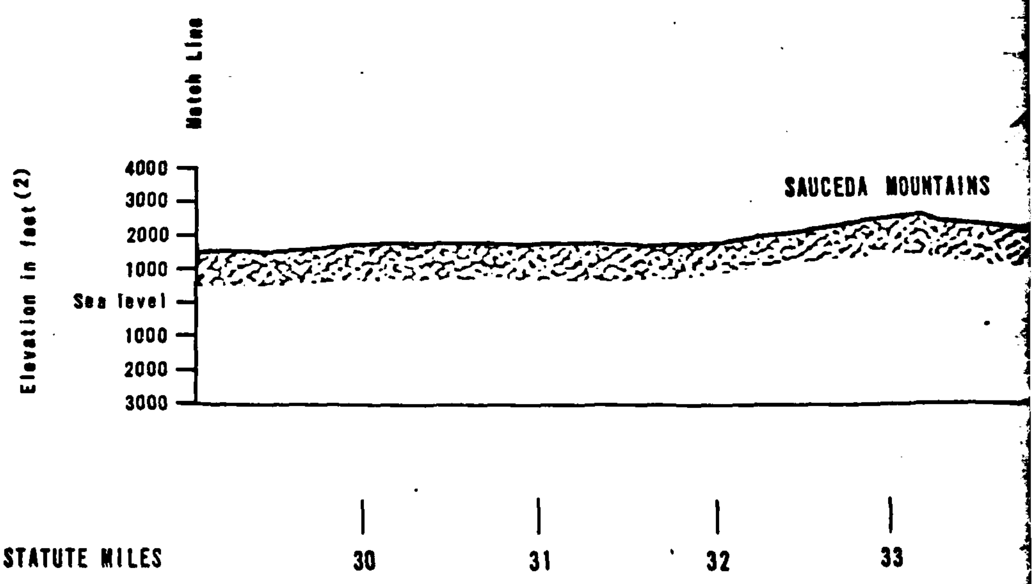
LOCATION OF GEOLOGIC SECTION LINE



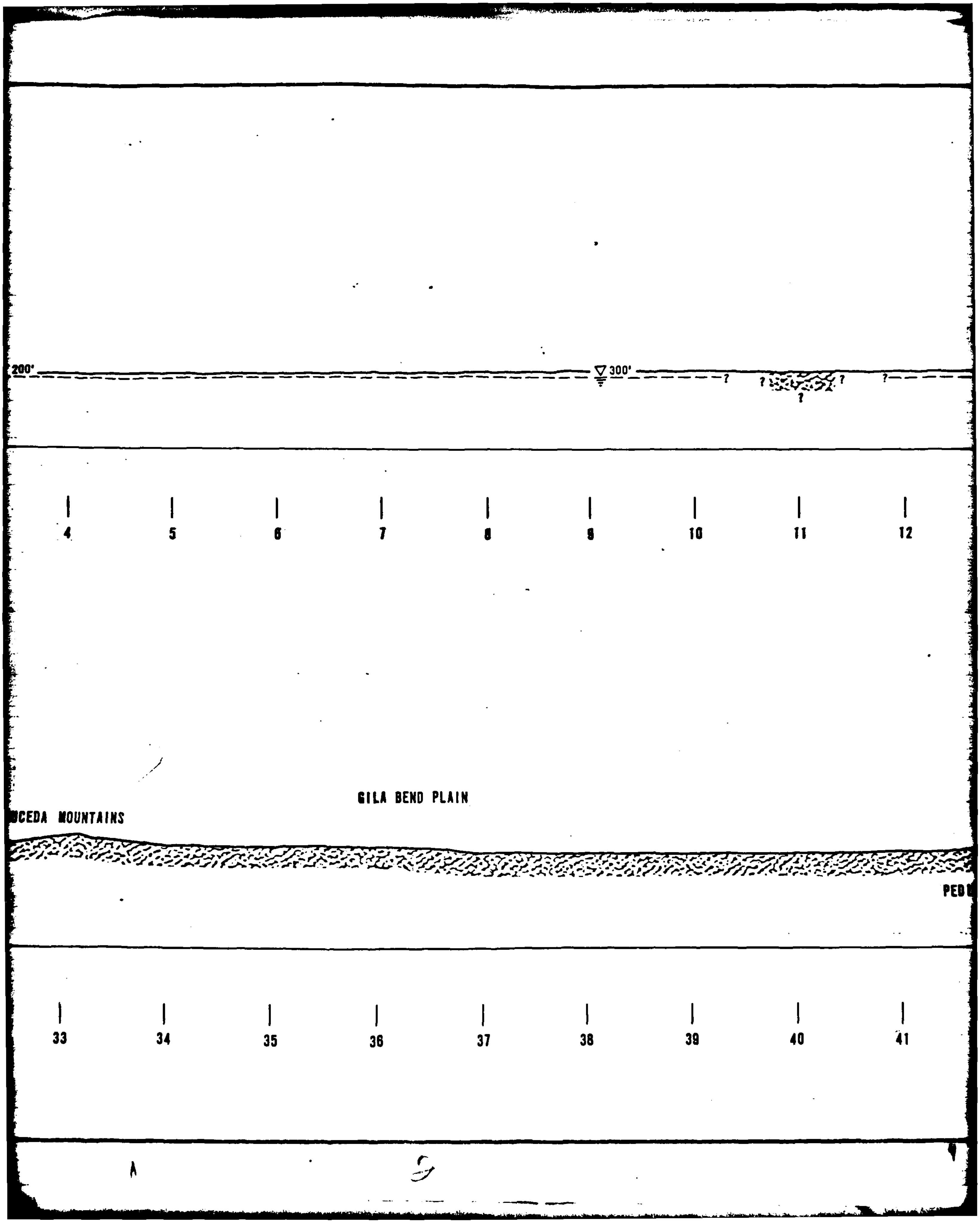
C DESCRIPTIONS
ACCURATE.
VE TO MEAN SEA LEVEL.
ALE 0.0 TO 1.05,
TO 8.3

GEOLOGIC SECTION S'-S"	
MX SITING INVESTIGATION DEPARTMENT OF THE AIR FORCE - SAMSO	FIGURE I-3
FUGRO NATIONAL, INC.	

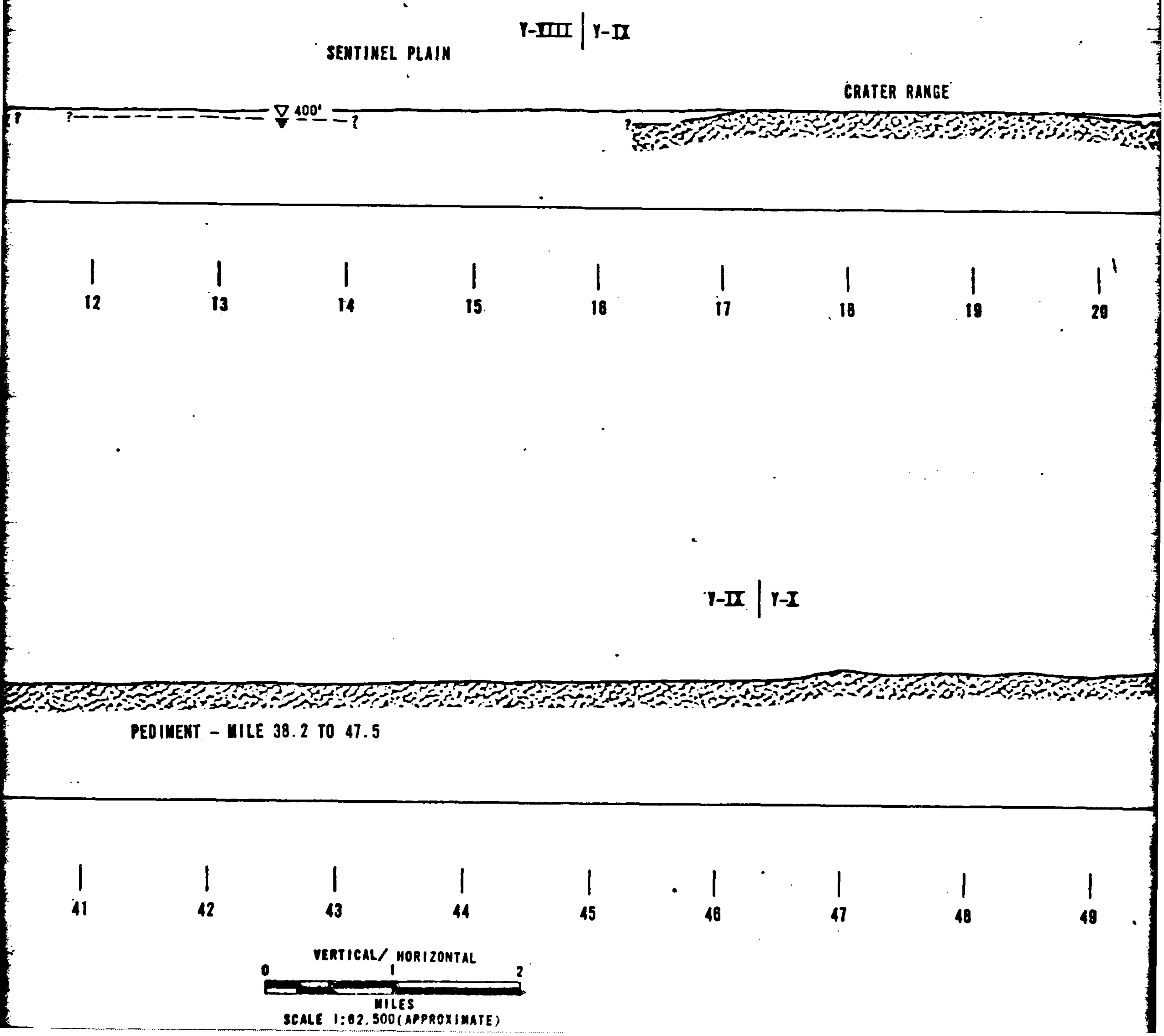


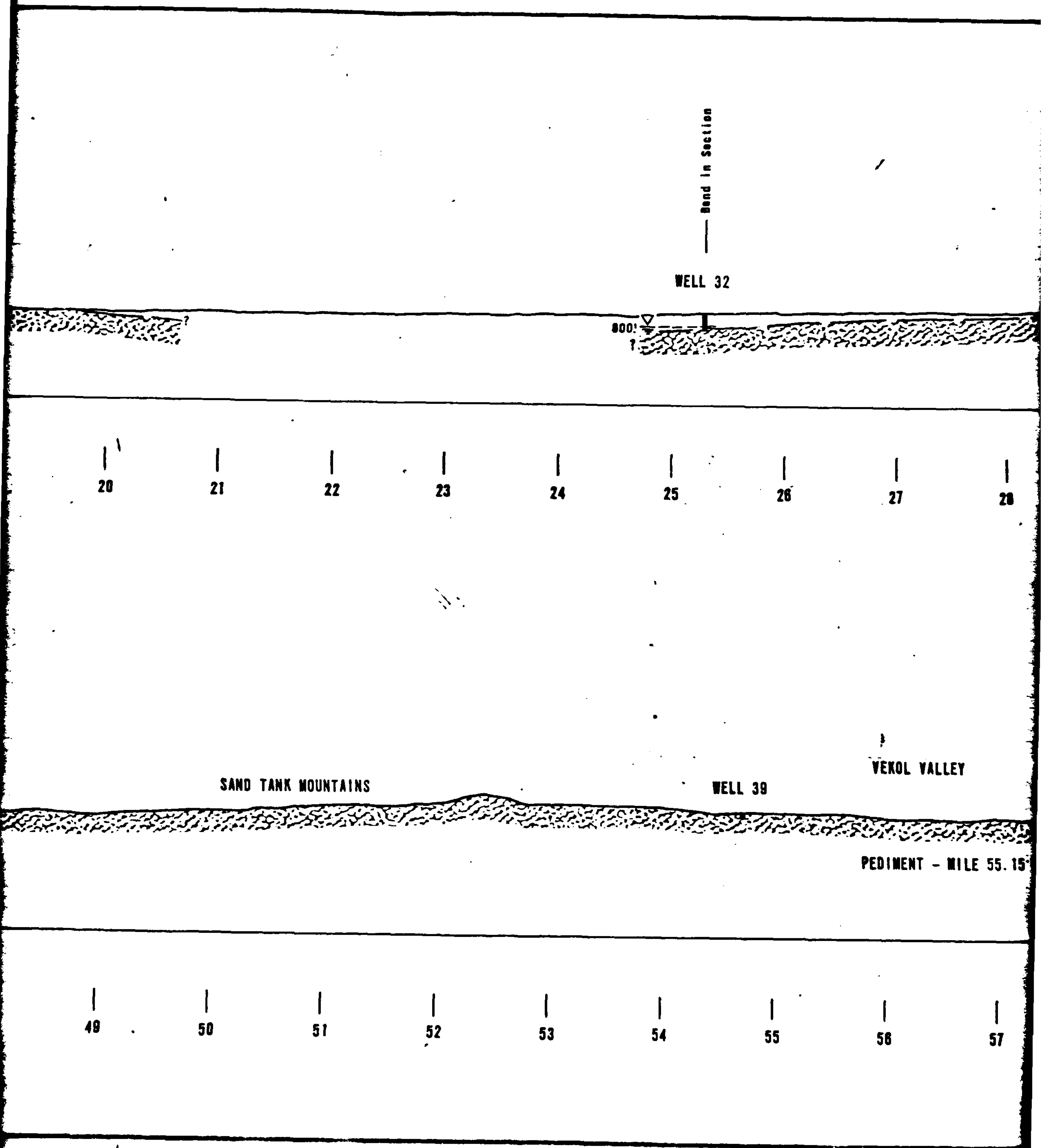


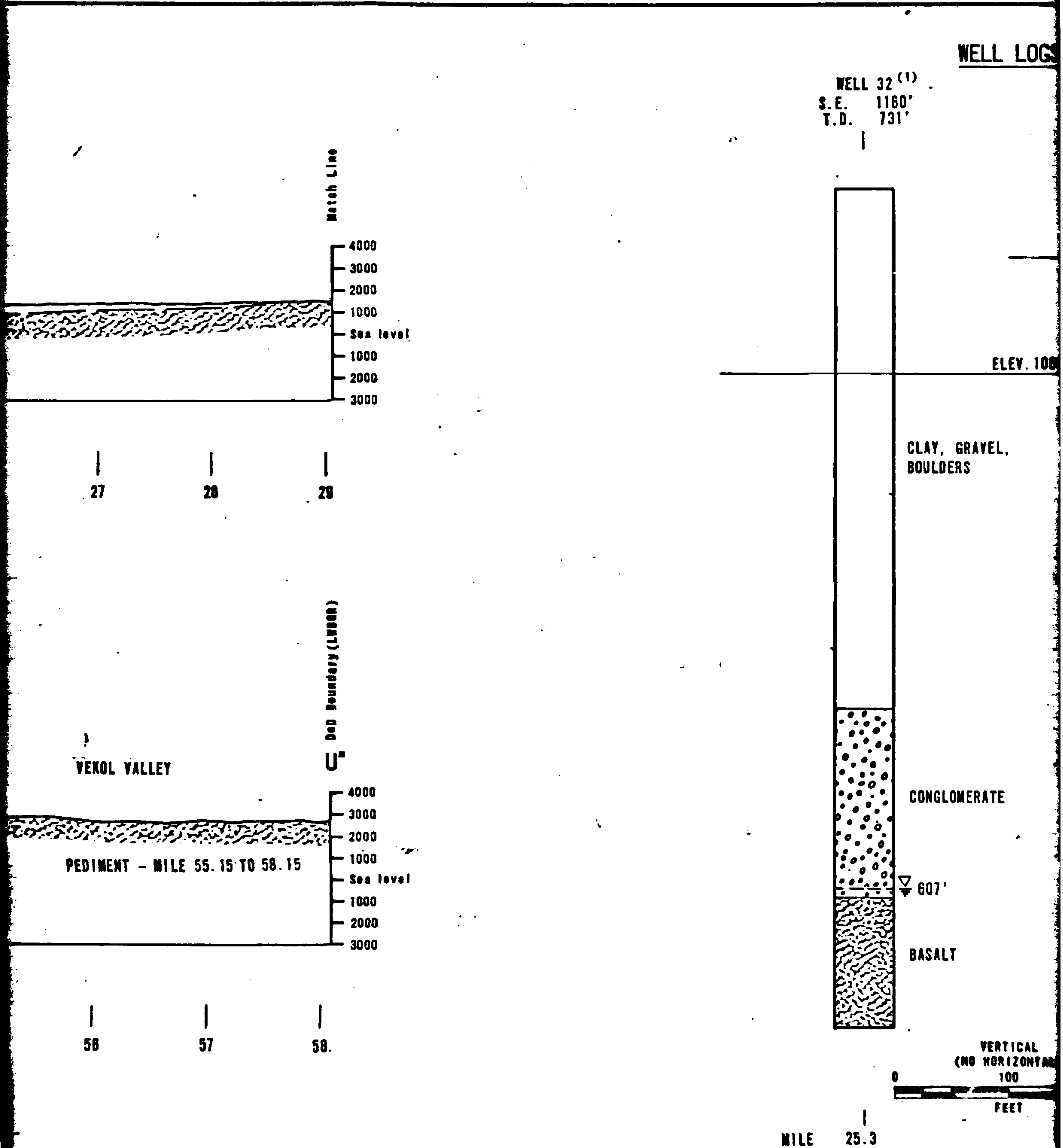
DATE: 30 JUNE 1975


200'
300'
4
5
6
7
8
9
10
11
12
GILA BEND PLAIN
UCEDA MOUNTAINS
33
34
35
36
37
38
39
40
41

GEOLOGIC SECTION U'-U''(3)



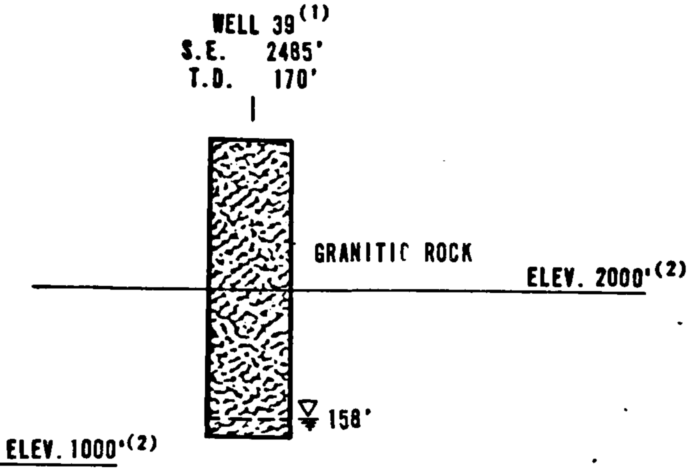

Bend in Section
WELL 32
800'
?
20
21
22
23
24
25
26
27
28
SAND TANK MOUNTAINS
WELL 39
VEKOL VALLEY
PEDIMENT - MILE 55.15
49
50
51
52
53
54
55
56
57



WELL LOGS
WELL 32 (1)
S.E. 1160'
T.D. 731'
ELEV. 100
CLAY, GRAVEL, BOULDERS
CONGLOMERATE
607'
BASALT
VERTICAL
(NO HORIZONTA
0
100
FEET
MILE 25.3
Match Line
4000
3000
2000
1000
Sea level
1000
2000
3000
27
28
29
DoD Boundary (LMBGR)
U
VEKOL VALLEY
PEDIMENT - MILE 55.15 TO 58.15
4000
3000
2000
1000
Sea level
1000
2000
3000
56
57
58.

5

WELL LOGS

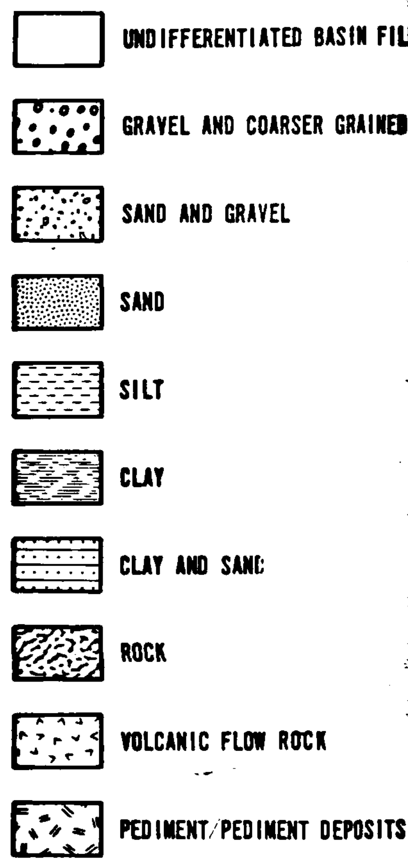


, GRAVEL,
DERS

LOMERATE

T

Lithologies
materi



NOTES:

(1) DRILLERS LOGS: LITHOLOGIC DESCRIPTIONS SHOULD NOT BE CONSIDERED ACCURATE.

(2) ALL ELEVATIONS ARE RELATIVE TO MEAN SEA LEVEL.

(3) DEPTH TO ROCK UNKNOWN - MILE 0.0 TO 16.3 AND MILE 20.65 TO 24.7

VERTICAL
(NO HORIZONTAL)
100 200
FEET

54.75

6

EXPLANATION

Lithologies shown in well logs represent predominant (greater than 70 percent) material. Appropriate modifiers appear to the right of each well log.

- UNDIFFERENTIATED BASIN FILL
- GRAVEL AND COARSER GRAINED
- SAND AND GRAVEL
- SAND
- SILT
- CLAY
- CLAY AND SAND
- ROCK
- VOLCANIC FLOW ROCK
- PEDIMENT/PEDIMENT DEPOSITS

?

GEOLOGIC CONTACT – Solid where data specific; dashed where approximate; queried where extrapolated or questionable.

? 250'

GROUNDWATER LEVEL – Queried where extrapolated or questionable.

100'

DEPTH TO GROUNDWATER IN BASIN-FILL DEPOSITS – Indicates depth to water in feet (100') where not graphically depicted due to small scale.

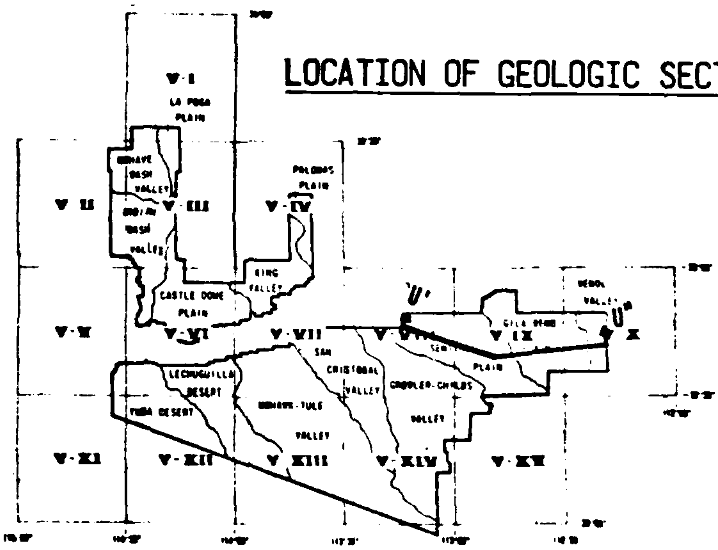
FAULT – Arrows indicate relative movement.

WELL 5
[1000'/ S40E]

WELL – Brackets indicate well projected 1000 feet to geologic section line on azimuth south 40 degrees east.

RIPTIONS
TE.
MEAN SEA LEVEL.
0 TO 16.3

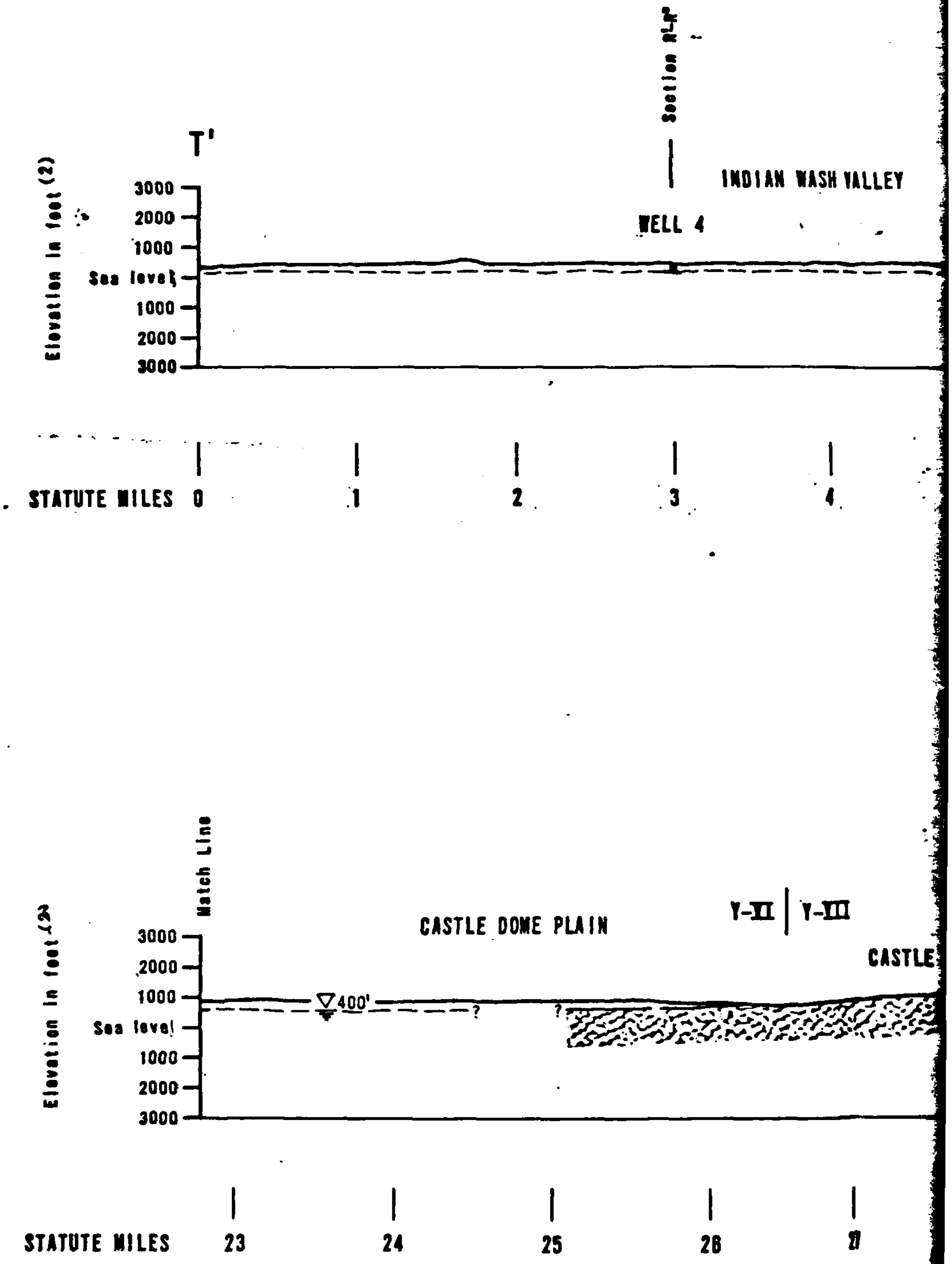
LOCATION OF GEOLOGIC SECTION LINE



GEOLOGIC SECTION U'-U''

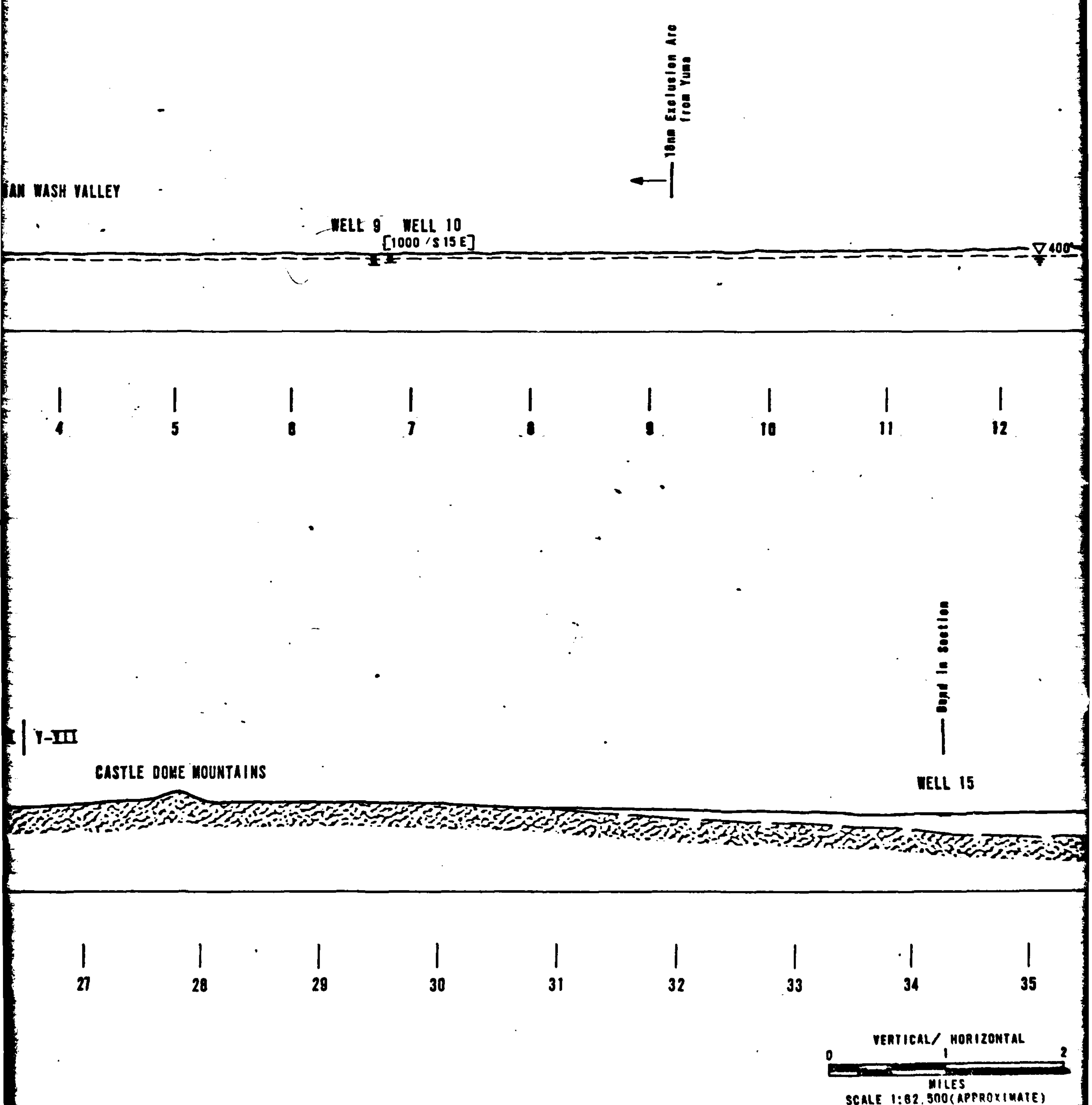
MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

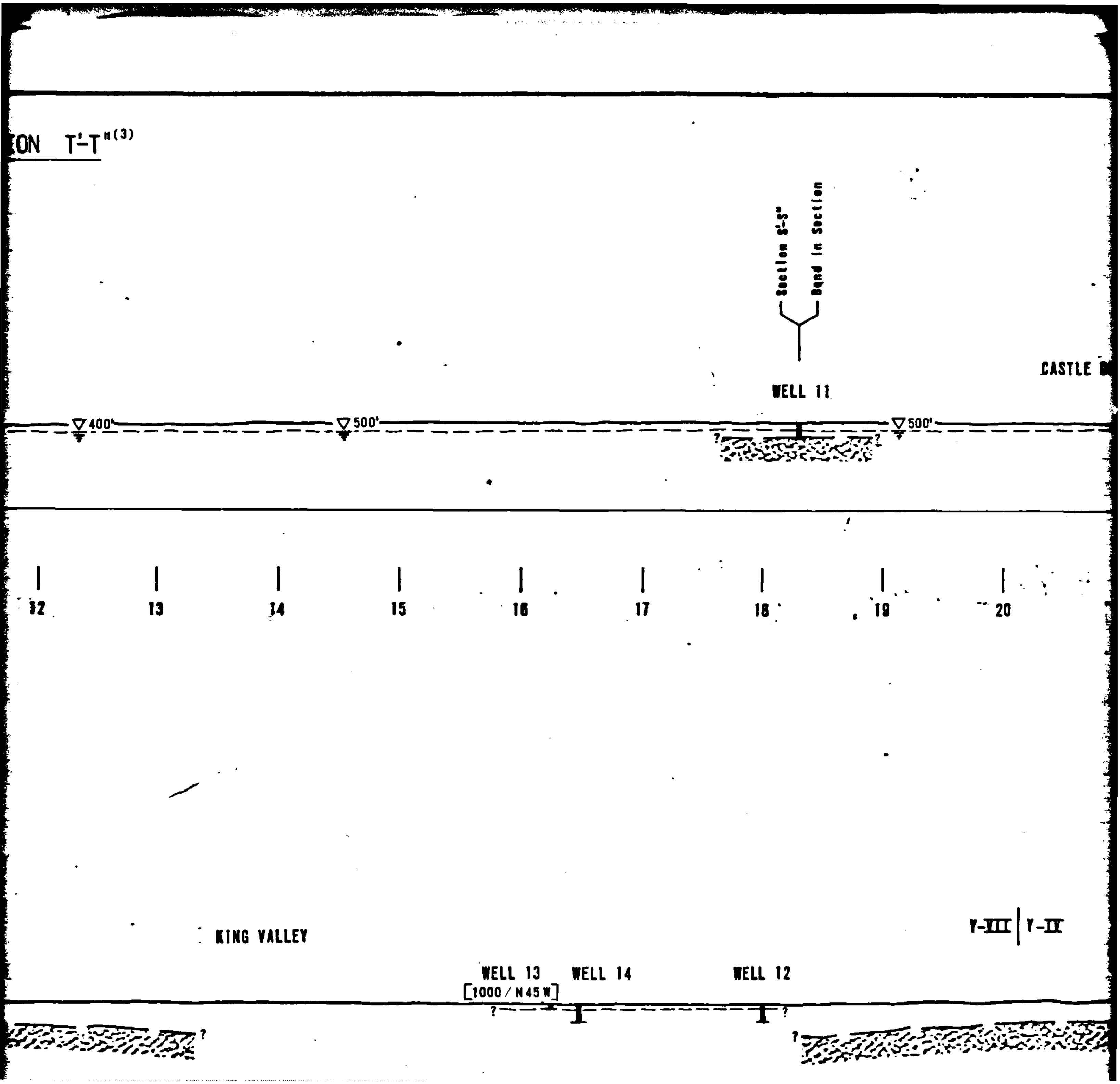
FIGURE
1-5

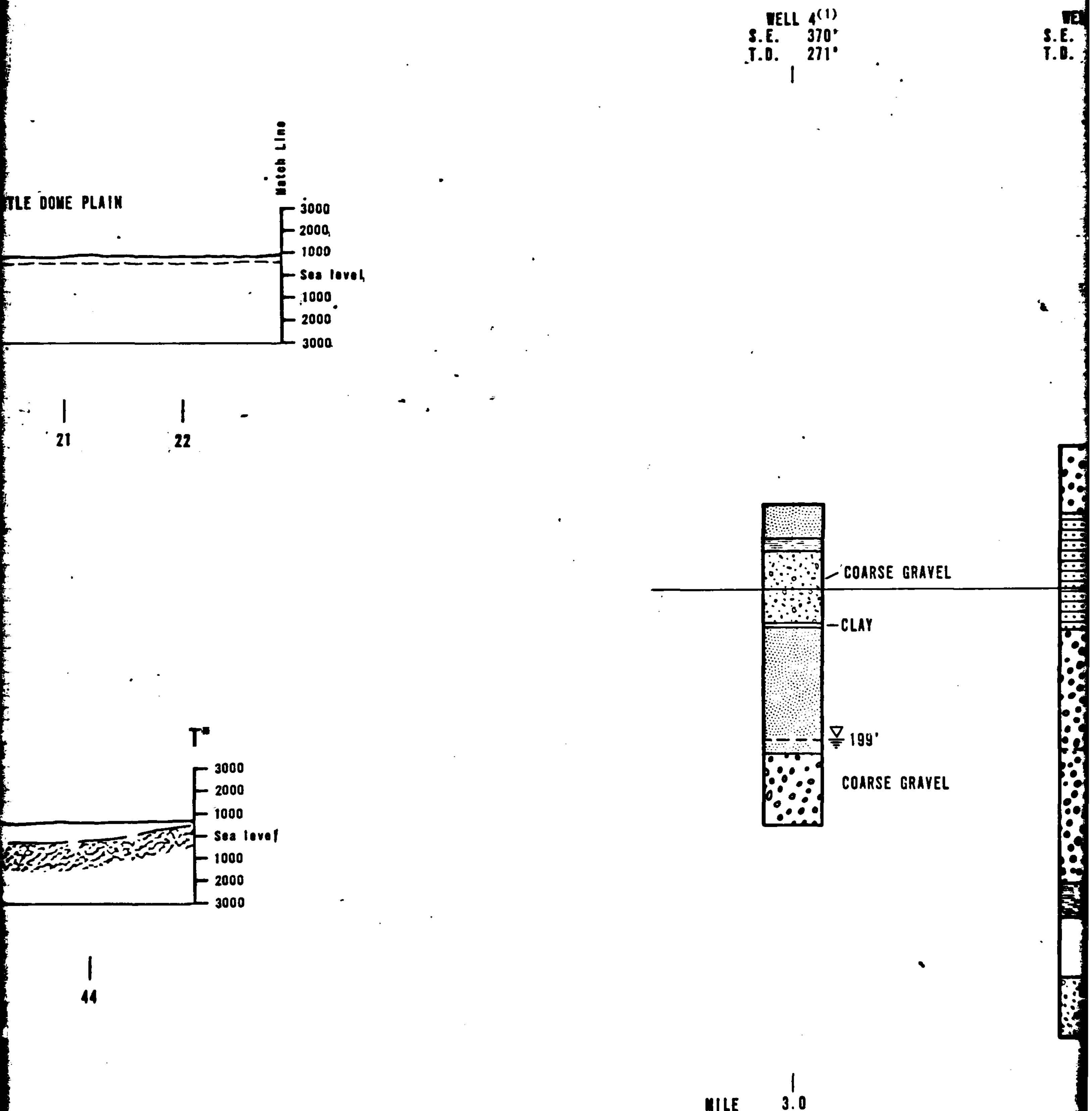


DATE: 30 JUNE 1975

GEOLOGIC SECTION T'-T"



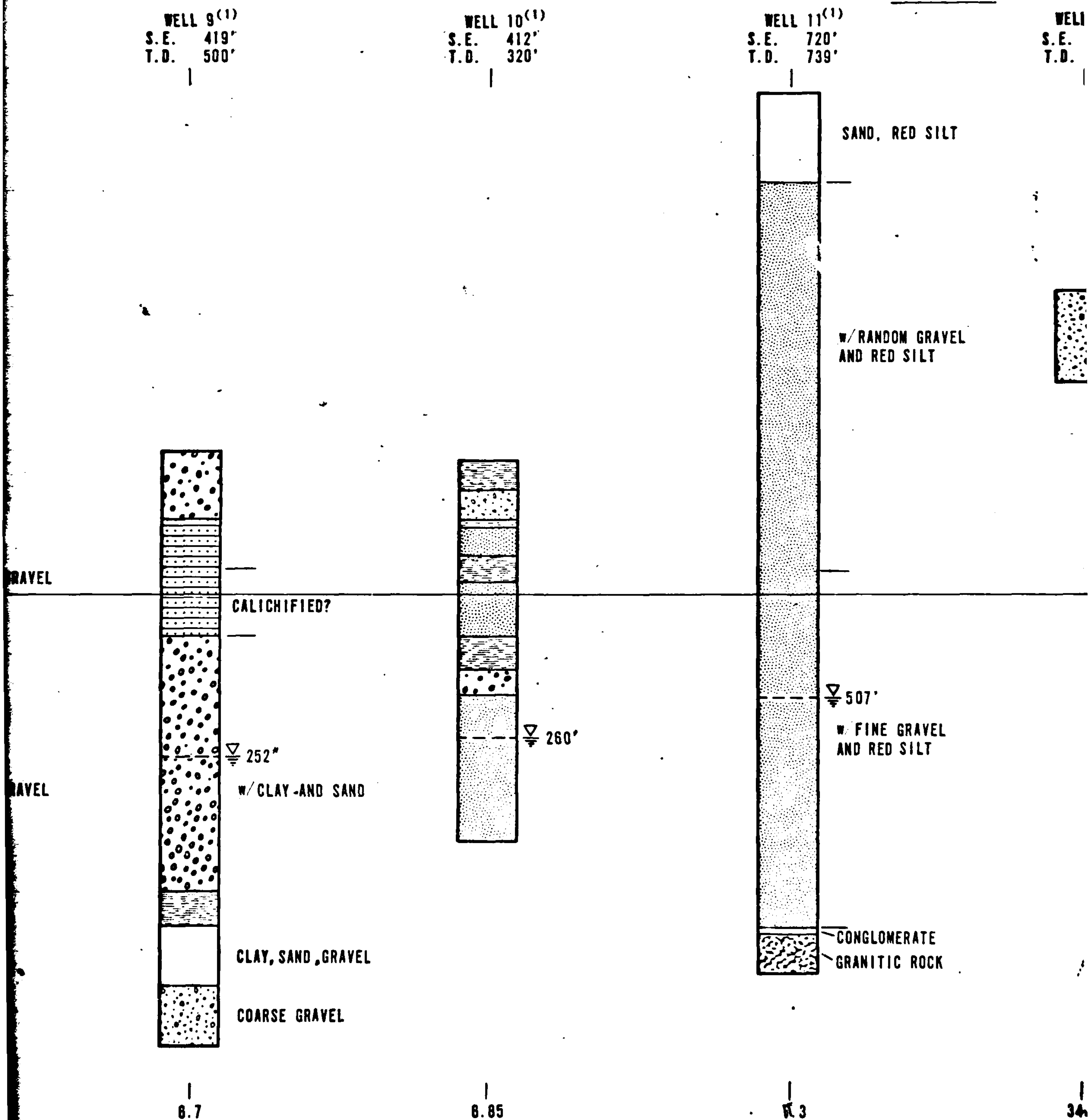

ON T'-T"(3)
Section S'-S"
Bend in Section
WELL 11
CASTLE
400'
500'
500'
12
13
14
15
16
17
18
19
20
KING VALLEY
Y-VIII | Y-IX
WELL 13
[1000 / N 45 W]
WELL 14
WELL 12



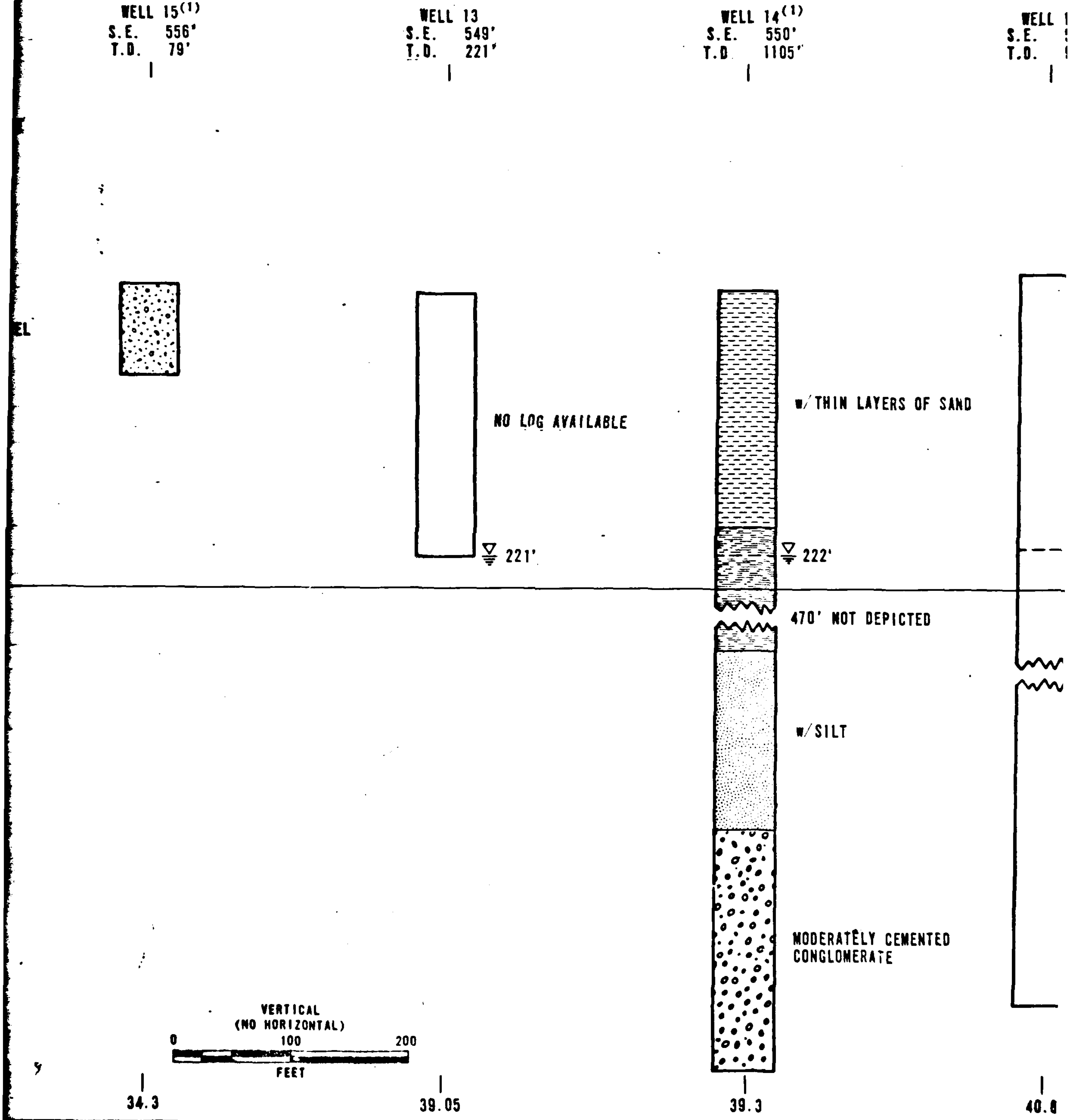
WELL 4(1)
S.E. 370'
T.D. 271'
Match Line
TLE DOME PLAIN
3000
2000
1000
Sea level
1000
2000
3000
21
22
COARSE GRAVEL
CLAY
199'
COARSE GRAVEL
T
3000
2000
1000
Sea level
1000
2000
3000
44
MILE 3.0

4

WELL LOGS


WELL 9(1)
S.E. 419'
T.D. 500'
WELL 10(1)
S.E. 412'
T.D. 320'
WELL 11(1)
S.E. 720'
T.D. 739'
SAND, RED SILT
W/RANDOM GRAVEL AND RED SILT
CALICHIFIED?
252'
W/CLAY AND SAND
CLAY, SAND, GRAVEL
COARSE GRAVEL
260'
507'
W. FINE GRAVEL AND RED SILT
CONGLOMERATE
GRANITIC ROCK
6.7
6.85

LOGS


WELL 15(1)
S.E. 556'
T.D. 79'
WELL 13
S.E. 549'
T.D. 221'
WELL 14(1)
S.E. 550'
T.D 1105'
WELL
S.E.
T.D.
EL
NO LOG AVAILABLE
221'
w/THIN LAYERS OF SAND
222'
470' NOT DEPICTED
w/SILT
MODERATELY CEMENTED
CONGLOMERATE
VERTICAL
(NO HORIZONTAL)
0
100
200
FEET
34.3
39.05
39.3
40.8

6

AD-A113 214 FUGRO NATIONAL INC LONG BEACH CA F/G 8/6

MX SITING INVESTIGATION. VOLUME IIB. GEOTECHNICAL REPORT, YUMA --ETC(U)

JUN 75 F04701-74-C-0013

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6 OF 6

END

DATE FILMED

5-82

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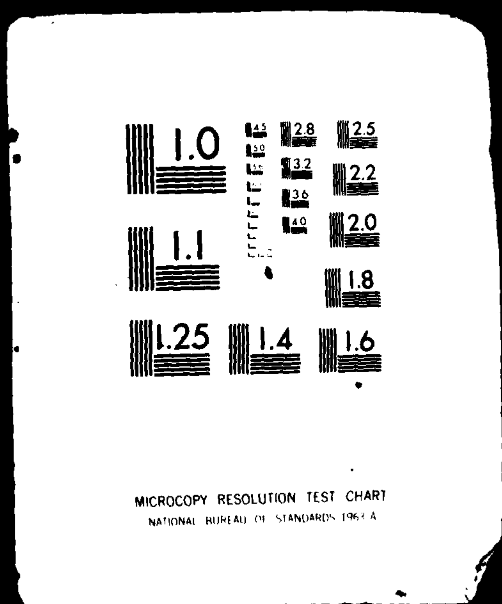
SIFIED

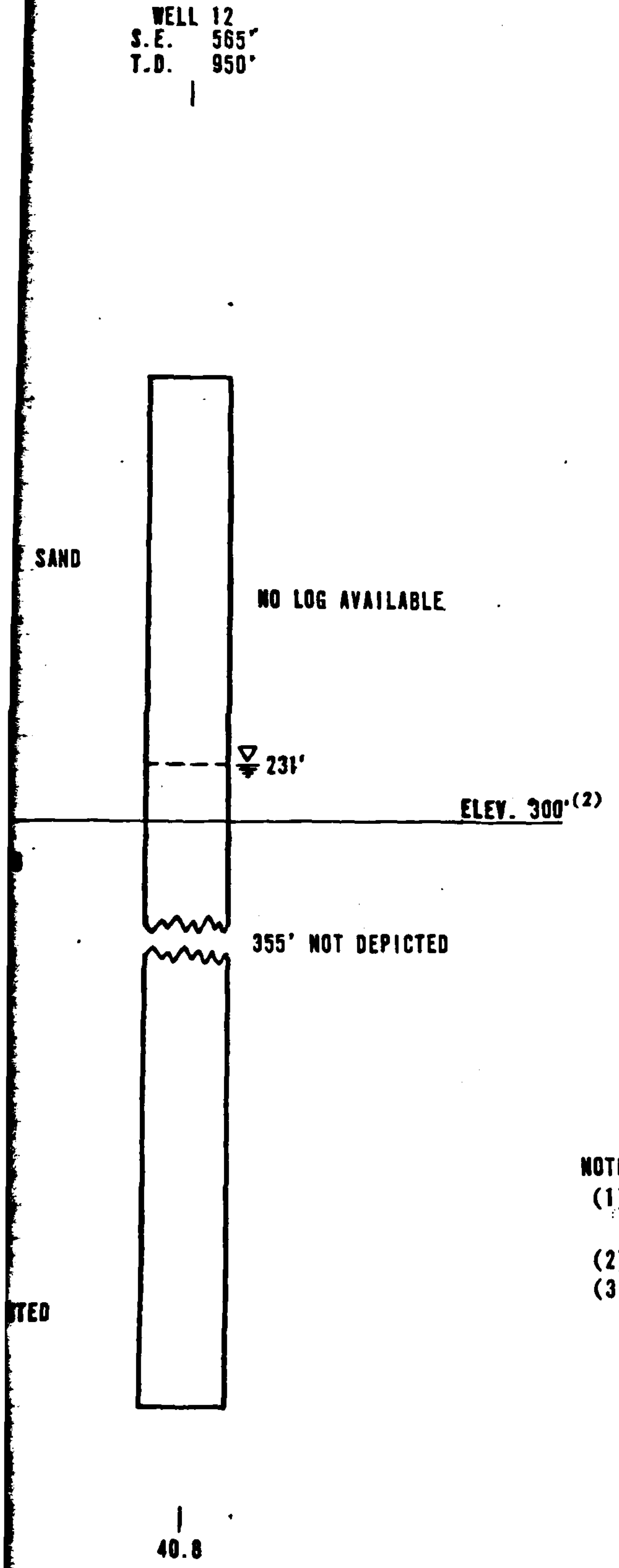
6 OF 6

AD A113214

SAND



TED



Lithologies sho
material.

UNDIFFERENTIATED BASIN FILL

GRAVEL AND COARSER GRAINED

SAND AND GRAVEL

SAND

SILT

CLAY

CLAY AND SAND

ROCK

VOLCANIC FLOW ROCK

PEDIMENT/PEDIMENT DEPOSITS

NOTES:
(1) DRILLERS LOGS: LITHOLOGIC DESCRIPTIONS SHOULD NOT BE CONSIDERED ACCURATE
(2) ALL ELEVATIONS ARE RELATIVE TO MEAN SEA LEVEL.
(3) DEPTH TO ROCK UNKNOWN - MILE 0.0 TO 17.65, MILE 18.9 TO 25.1, AND MILE 36.1 TO 41.1

EXPLANATION

Lithologies shown in well logs represent predominant (greater than 70 percent) material. Appropriate modifiers appear to the right of each well log.

UNDIFFERENTIATED BASIN FILL

GRAVEL AND COARSER GRAINED

SAND AND GRAVEL

SAND

SILT

CLAY

CLAY AND SAND

ROCK

VOLCANIC FLOW ROCK

PEDIMENT/PEDIMENT DEPOSITS

GEOLOGIC CONTACT – Solid where data specific; dashed where approximate; queried where extrapolated or questionable.

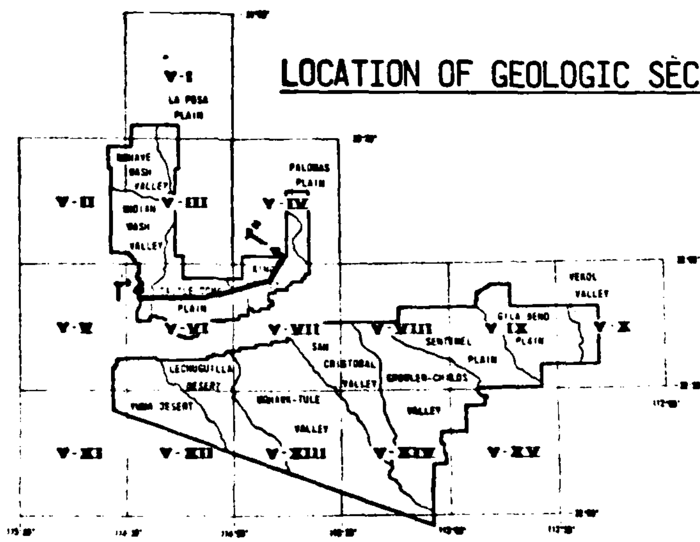
250' GROUNDWATER LEVEL – Queried where extrapolated or questionable.

100' DEPTH TO GROUNDWATER IN BASIN-FILL DEPOSITS – Indicates depth to water in feet (100') where not graphically depicted due to small scale.

FAULT – Arrows indicate relative movement.

WELL 5 [1000'/S40E]

WELL – Brackets indicate well projected 1000 feet to geologic section line on azimuth south 40 degrees east.



LOCATION OF GEOLOGIC SECTION LINE

TIONS

SEA LEVEL.
17.65,
41.1

GEOLOGIC SECTION T'-T"

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE 1-4

FUGRO NATIONAL, INC.

ILMED

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